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A WINDOW TO CHILD HEALTH IN THE TERAI

NEPAL NUTRITION INTERVENTION PROJECT - SARLAHI (NNIPS)

A Window to Child Health in the Terai

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Chapter 1: The NNIPS Organization

The Nepal Nutrition Intervention Project - Sarlahi (NNIPS) represents a series of USAID-supported, population-based nutrition, health and blindness prevention research projects conducted in the east-central terai district of Sarlahi over the past decade. The studies have been conducted collaboratively by The School of Hygiene and Public Health at Johns Hopkins University, Nepal Netra Jyoti Sangh and the Sushil Kedia Seva Mandir, through agreements with the Social Welfare Council and approval of the Nepal Health Research Council of His Majesty's Government of Nepal.

The NNIPS study area encompasses 30 Village Development Committees (VDC) with a total population of approximately 170,000 people. It's culture and geography are similar to those in other areas of the terai and the rural Gangetic flood plain. Health statistics emerging from Sarlahi mirror those on the national level, indicating a wider representativeness of the district. For these reasons, research findings that emerge from NNIPS in Sarlahi can be generalized to much larger segments of the Nepalese population and are relevant to the region. It is the desire of NNJS and Johns Hopkins University that HMG and other INGO/NGOs view NNIPS as a national and regional resource for vital health and nutrition information.

NNIPS is mandated to conduct applied research to reveal how infant, child and maternal mortality, morbidity and nutritional blindness can be lowered through replicable, public health interventions and to provide a basis for policy and program decisions. Field work, clinical research and laboratory work are carried out in Sarlahi. Data management, additional laboratory, logistical and administrative support are carried out on the grounds of the Nepal Eye Hospital in Tripureshwor, Kathmandu. Major studies carried out by NNIPS to date include the following:

NNIPS-1 (1988-92): NNIPS-1 was a 30,000-child randomized, double-masked community trial that assessed the impact of 4-monthly vitamin A supplementation on preschool aged child mortality, morbidity and growth (see Appendix I). High-potency vitamin A was found to reduce preschool child mortality by 30%. The reduction was strongest among deaths associated with diarrhea, dysentery, febrile illnesses and measles. It was calculated that approximately 25,000 preschool child deaths could be averted each year in Nepal with an adequate vitamin A program. These findings, coupled with results from other studies in Jumla and elsewhere, led directly to the establishment of Nepal's own National Vitamin A Program to improve child survival through twice-yearly vitamin A supplementation.

NNIPS-2 (1993-1997): NNIPS-2 was the second field study in Sarlahi District, carried out from 1994 to 1997 to evaluate the effects of low-dose, weekly, vitamin A or beta-carotene supplementation of women on fetal, early infant and maternal health and survival. Maternal pregnancy-related mortality was reduced 40% (p<.04) by vitamin A and 49% (p<.01) by beta-carotene. Approximately 45,000 married women of child-bearing age participated in the trial. Over 23,000 pregnancies were followed for health and vital outcomes. The study provides information on risk factors of night blindness, gestational maturity of pregnancies, spontaneous abortion, still birth and birth defects not previously measured on a population basis. Data on maternal lifestyle factors, such as smoking and drinking habits, work load during and after pregnancy, dietary intake, protein-energy malnutrition, anemia, iron and iodine status, prevalence of malaria and intestinal parasitismia will be evaluated for their effects and associations with fetal loss, infant morbidity, growth and mortality, and maternal morbidity and mortality. "Verbal autopsies" were conducted to ascertain causes of infant and maternal deaths. The impact of a small steady stream of income for women on family health and economic well-being has been followed by regularly interviewing the 430 locally hired NNIPS women workers and an equal number of controls. In addition to scientific publications, a NNIPS-2 monograph with major findings of this large trial will be published by the year 2000.

NNIPS-1 Follow-up 1 (1997-98): In late 1997, a follow-up survey of a subsample of children enrolled in NNIPS-1 was conducted to determine long term benefits of vitamin A supplementation, to define the health and nutritional status of school-aged children in the terai and to measure the influences of early childhood illnesses and malnutrition on health, nutritional status, growth and survival through the prepubescent school aged years. Resources permitting, these children will continue to be followed every six years; that is during adolescence (Follow-up 2) and early adulthood (Follow-up 3) to examine relationships between early childhood health and nutritional status and reproductive and adult health and survival.

DIVA (1991-1993): DIVA (for Dietary Initiatives for Vitamin A) was a population-based study of intra-household dietary patterns and household behaviors exhibited by the children and parents of families with xerophthalmic children. It uniquely combined intensive anthropologic observational methods with an adequately sampled epidemiologic design (90 case-control pairs). Findings show that October to December may be an important time period for reducing risk of vitamin A deficiency through diet and that children in homes with a history of xerophthalmia tend to be subjected to poorer child caring practices in their homes compared to children from households where xerophthalmia has not previously occurred. Thus, poor child care appears to be an underlying cause of chronic dietary vitamin A inadequacy. These and other findings may stimulate new approaches for providing nutrition, health and *behavioral* education to prevent vitamin A deficiency in the future. A separate monograph will be forthcoming on the findings of DIVA.

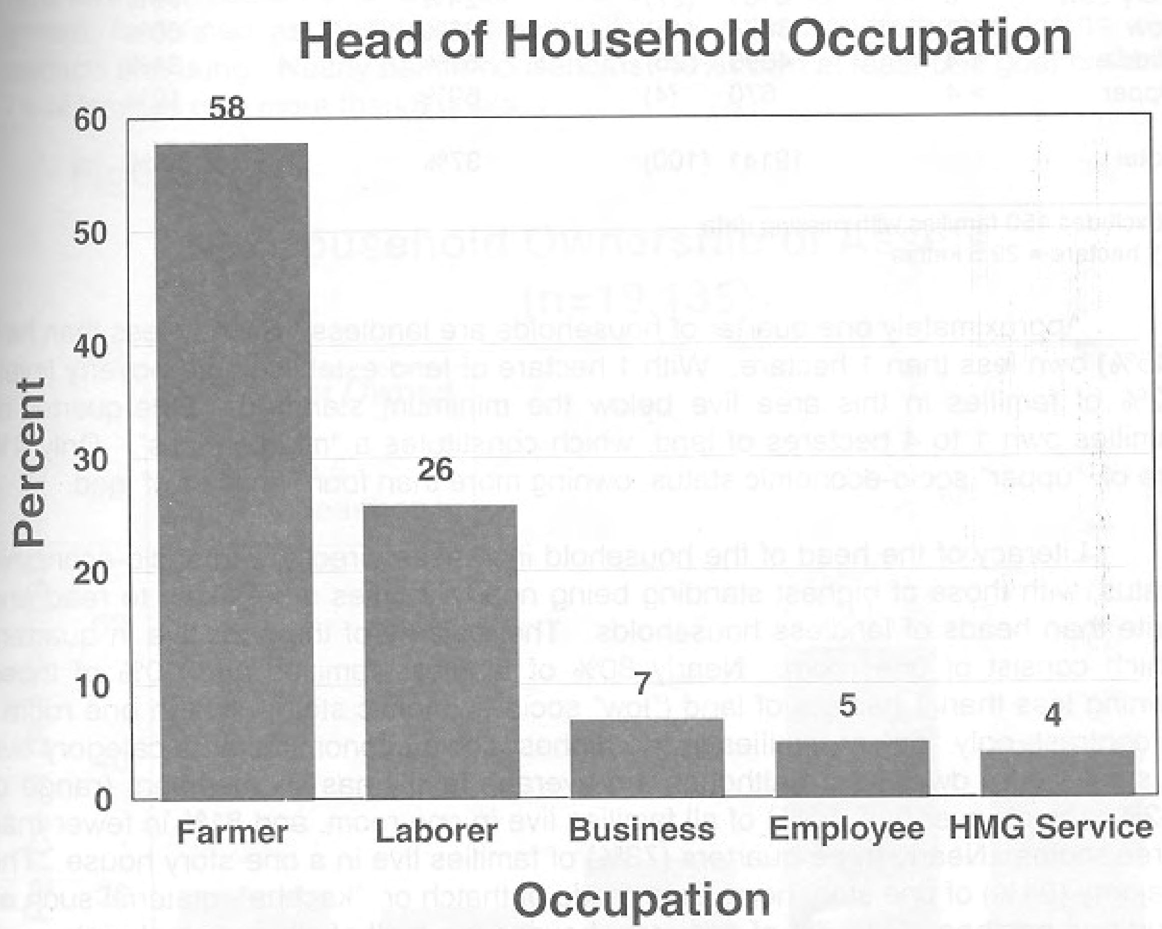
2

SOCIO-ECONOMIC VIEW

Sarlahi is a rural, plains district in Janakpur Zone in the Central terai of Nepal. It shares and contributes to the general ecology, culture and socio-economic status of the east-central terai.

In NNIPS-1, socio-economic data were collected on 19,291 families. The results paint a picture of a relatively poor, agrarian culture. Over half (58%) of heads of household in Sarlahi are farmers, and another 26% are day laborers who are, for the most part, employed in the agricultural sector. A small percentage (12%) are involved in private business, either as shopkeepers or employees. Four percent are His Majesty's Government (HMG) employees (**Figure 2.1**).

Figure 2.1



In such an agriculturally focused area, land ownership has been recognized as a proxy for income (1) and was used to establish categories of socio-economic status. Families of low socio-economic status are those gauged to be living below the poverty line established by the government of Nepal in 1990, after estimating the ize of 1990 land holdings required to generate such an income (~1 hectare)(1, 2). The top ceiling for the middle socio-economic category (4 hectares) is adopted from estimates by community leaders and the Sarlahi District Agricultural Officer (2). Families with land holdings beyond this ceiling (>4 hectares) can be considered to be in the upper socio-economic category. **Table 2.1** categorizes this population by socio-economic status, based on land ownership, and shows how other measures of social and economic standing, such as literacy and the size of family living quarters, closely track and validate land ownership as a proxy for socio-economic status in the terai. The categories described in **Table 2.1** are used when referring to socio-economic status throughout this report.

Table 2.1: Socio-economic Status of Households
n=19141*

SES Category	Land owned (Hectares)**	Households No.	(%)	Head of HH Literacy	Families living in a 1-room house
Very Low	0	5101	(27)	24%	79%
Low	< 1	8674	(45)	36%	60%
Middle	1-4	4696	(25)	51%	31%
Upper	> 4	670	(4)	69%	10%
Total		19141	(100)	37%	56%

* Excludes 150 families with missing data
**1 hectare = 29.5 kattas

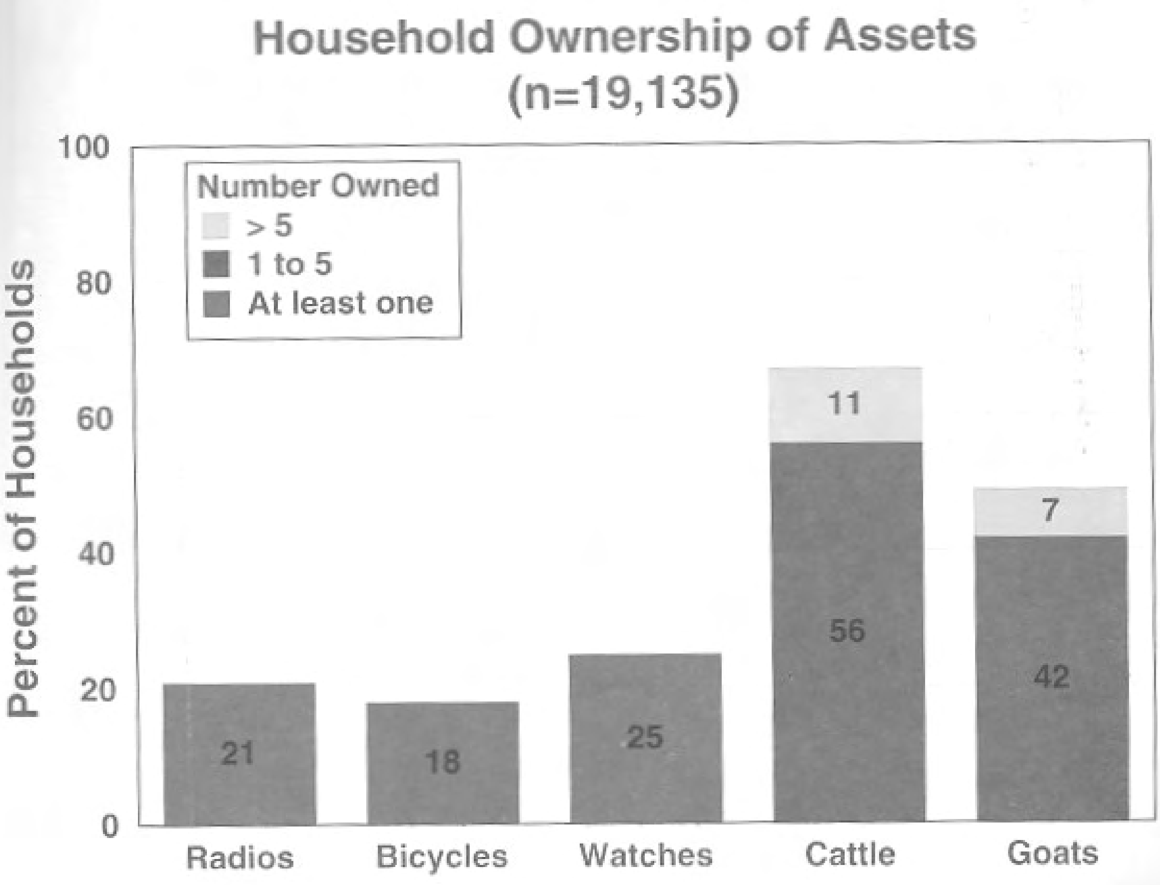
Approximately one quarter of households are landless. Slightly less than half (45%) own less than 1 hectare. With 1 hectare of land establishing a poverty level, 72% of families in this area live below the minimum standard. One-quarter of families own 1 to 4 hectares of land, which constitutes a "middle class". Only 4% are of "upper" socio-economic status, owning more than four hectares of land.

Literacy of the head of the household increases directly with socio-economic status, with those of highest standing being nearly 3 times more likely to read and write than heads of landless households. The majority of the poor live in quarters which consist of one room. Nearly 80% of landless families and 60% of those owning less than 1 hectare of land ("low" socio-economic status) live in one room. In contrast, only 10% of families in the highest socio-economic status category live in single-room dwellings. Although the average family has six members (range of 2-20 people), over half (56%) of all families live in one room, and 81% in fewer than three rooms. Nearly three-quarters (73%) of families live in a one-story house. The majority (94%) of one story homes are made of thatch or "kachha" material such as mud and bamboo. Only 6% of one-story houses are built of stronger materials such as wood or cement. About 27% of families live in two story homes, half of which (51%) are thatch or kachha, 43% wooden and 6% brick or cement.

About 20% of households in this area have potable water on their premises. Forty-three percent of households must walk less than 5 minutes to find water and another 20% find water within 10 minutes of their home. The remaining one-fifth of households must walk longer to reach their nearest water source. Water collection is one of the most time-consuming chores that must be carried out each day. Fetching water, and most other household tasks, are performed mainly by the women in the family. As would be expected, servants are few with only 8% of households having 1 and 3% employing 2 or more servants.

Types of household assets that reflect wealth in this population are few and basic as seen in **Figure 2.2** (which excludes missing data for 156 families out of 19,291 surveyed). Approximately 20% to 25% of families own at least one radio, bicycle or watch. However, 61% of households own none of these items. Livestock ownership represents an important form of capital investment in this population. Thus, expendable income tends to be directed toward ownership or "rental" of livestock. Over half of all households own or rent at least one cow or buffalo, but only 11% own or rent more than five of these large animals, representing a minimum herd size that could be considered to be of commercial value. *Rental*, in this context, is defined as feeding and caring for an animal in exchange for its milk products and dung. Nearly half of households (49%) own at least one goat but only 7% of families own more than 5 goats.

Figure 2.2



In summary, Sarlahi is an agrarian society in which families live in simple, sparse quarters, and farm their small plots of land or labor on other's fields. It is a poor environment in which nearly three quarters of the population may be considered to live below the poverty line established by the government of Nepal.

3

DEMOGRAPHIC PROFILE

The distributions of individuals by age, sex and literacy (**Tables 3.1 to 3.3**) provide data about the population studied in NNIPS-1 and the context within which health, growth and survival relationships have been observed. A few basic demographic and socio-economic characteristics are summarized here.

There were equal proportions of preschool children at each year of age enrolled in NNIPS-1 at baseline (**Table 3.1**). At each age there were slightly more boys than girls. This pattern may reflect a higher birth rate for boys, or greater mortality of young female infants (see Chapter 7) or a combination of these two influences.

The vast majority of heads of households with preschool-aged children in Sarlahi were male (98%), of whom 60% are between 20 and 39 years of age (**Table 3.2**). Only 1% were below 20 years. Female heads of household tended to be older with 53% being 40 or more years of age, compared to 40% of male heads of household in this older age group.

Literacy is a measure of human development and potential. Literacy was assessed by asking heads of household if they could read and write a letter in any language (**Table 3.3**). Thirty-eight percent of male heads responded that they could; only 6% of female heads of household reported being able to do so. Younger male adults were 50% more likely to be literate than older men, likely reflecting persistent efforts by the government to improve schooling over the past few decades. Younger women were nearly twice as likely as older female heads of household to be literate, but the percentage (11%) was still extremely low (see more complete discussion in Chapter 10).

Table 3.1: Age and Sex Distribution of Preschool Children
n=27,542

Age in Months	Boys No.	Boys Col (%)	Girls No.	Girls Col (%)	Total No.	Total Col (%)
0-5	1413	(10)	1327	(10)	2740	(10)
6-11	1340	(10)	1306	(10)	2646	(10)
12-23	2848	(20)	2783	(21)	5631	(20)
24-35	2846	(20)	2680	(20)	5526	(20)
36-47	2647	(19)	2573	(19)	5220	(19)
48-60	3061	(22)	2719	(20)	5780	(21)
Total	14154	(100)	13388	(100)	27542	(100)
Row Percent	51%		49%		100%	

Table 3.2: Age and Sex of Heads of Households with Preschool Children
n=19,144*

Age (yr)	Male No.	Col (%)	Female No.	Col (%)
≤19	122	(1)	0	(0)
20-29	4653	(25)	44	(13)
30-39	6506	(35)	84	(25)
40-49	3898	(21)	81	(24)
≥50	3623	(19)	133	(29)
Total	18802	(100)	342	(100)
Row Percent	98%		2%	

* Excludes data for 147 families with missing data.

Table 3.3: Literacy of Heads of Households
n=19,131*

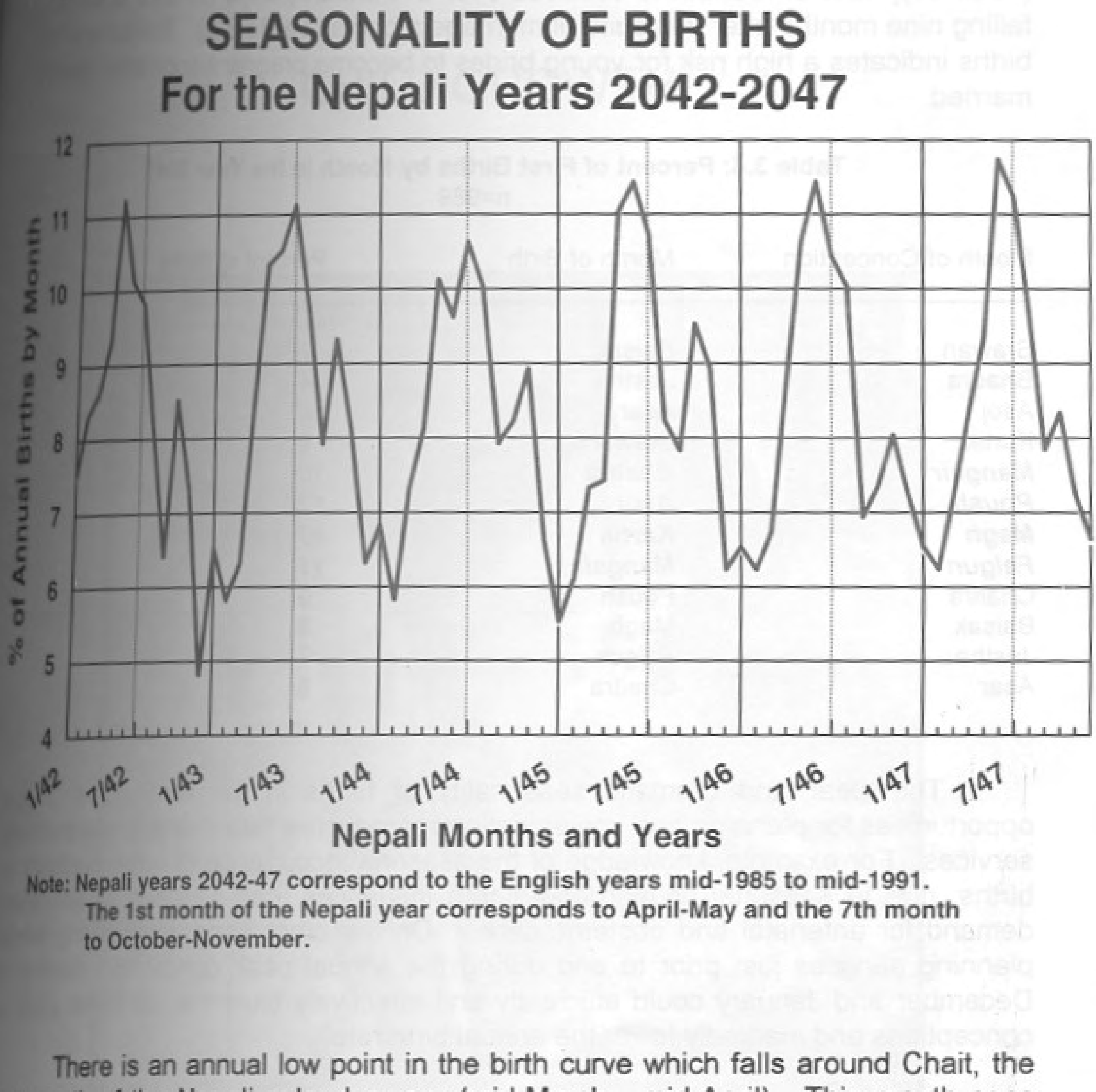
Age in years	Male No.	Col (%)**	Female No.	Col (%)
≤19	56	(46)	-	
20-29	2069	(45)	5	(11)
30-39	2514	(39)	5	(6)
40-49	1335	(34)	3	(4)
≥50	1124	(31)	8	(6)
Total Literacy	7098	(38)	21	(6)

* Excludes data for 160 families with missing data.
** Percent of respondents in each age group.

Seasonality of Births

Figure 3.1 depicts the percent of births occurring in each Nepali month of the year, over a five year period. The graph shows a repeated, yearly peak in the number of births around the Nepali month of Asoj (mid-Sept. to mid-Oct.). Approximately 11% of the total births in any one year occur during this single month, corresponding to a peak in conceptions about nine months earlier; that is, during the Nepali month of Pous (Dec.-Jan.). This period represents the post-rice and corn harvest season of the year, a time when food is generally sufficient, people tend to be better nourished, daylight hours are shortest and temperatures are coolest of the year, and when work in the fields is minimal.

Figure 3.1



Note: Nepali years 2042-47 correspond to the English years mid-1985 to mid-1991. The 1st month of the Nepali year corresponds to April-May and the 7th month to October-November.

There is an annual low point in the birth curve which falls around Chait, the last month of the Nepali calendar year (mid-March - mid-April). This month sees roughly half the annual percentage of births by month compared to the month of Pous. Nine months prior to Chait is early to mid-summer, the time of year when food shortage is widespread in terms of staple grains and vegetables, with rice and corn just being planted and not ready for harvesting for several months. The burden of field work at this time of year is very high, with both men and women spending long and tiring hours toiling in the fields preparing the ground for planting, doing the actual planting and/or weeding and cultivating. This is also the hottest and most humid time of year. This is also a high disease-prone time of year which may contribute to concurrent poor nutritional status of the population (see Chapter 6 for findings on children).

The distribution of first pregnancies follows conceptions during the marriage seasons in Nepal. Mangsir (mid-November to mid-December) is an important marriage month, along with Magh (mid-January to mid-February), Falgun (mid-February to mid-March), and Baisak (mid-April to mid-May). In the Nepali year 2047 (1990-91), 43% of first births occurred over a 4-month period (Bhadra to Mangsir) falling nine months after this suite of marriage months (**Table 3.4**). The curve of first births indicates a high risk for young brides to become pregnant soon after they are married.

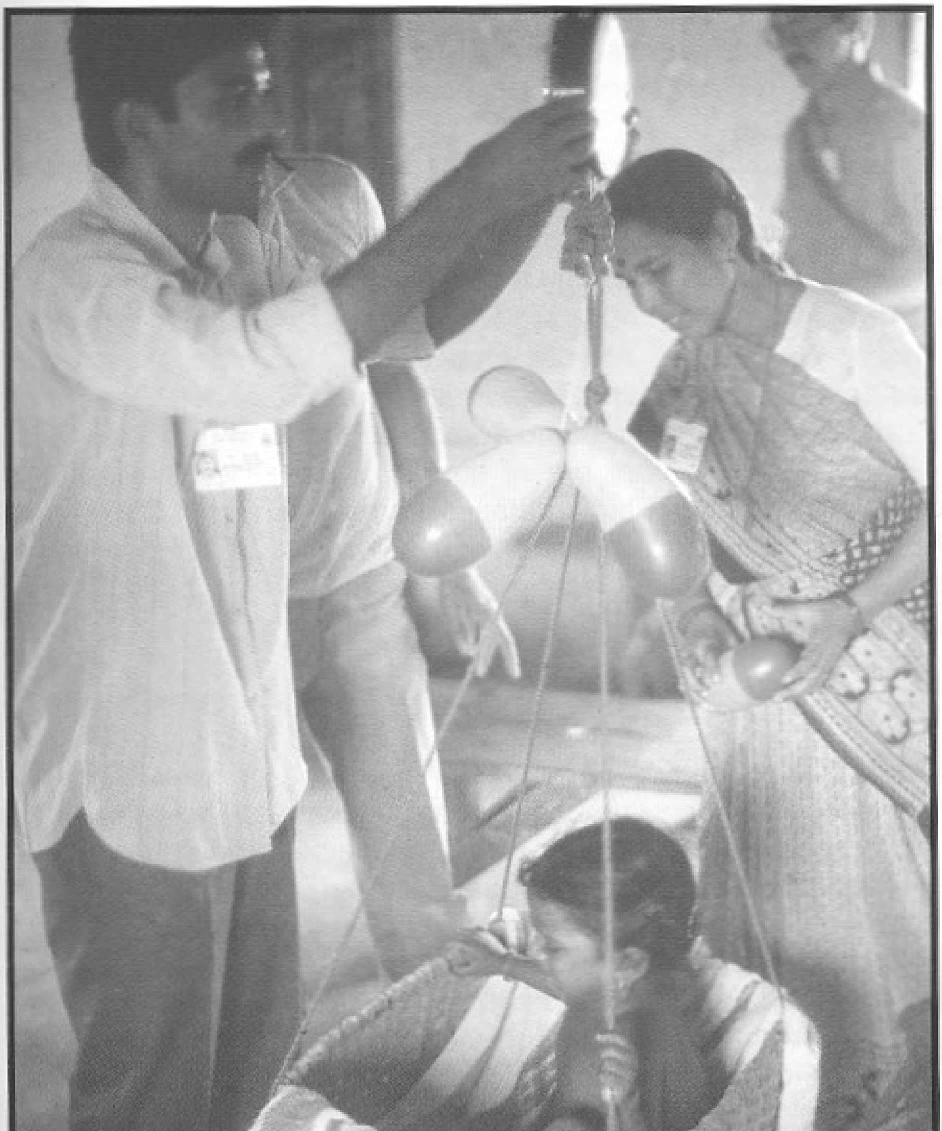
Table 3.4: Percent of First Births by Month in the Year 2047
n=969

Month of Conception	Month of Birth	Percent of Births
Srawan	Baisak	7
Bhadra	Jestha	4
Asoj	Asar	8
Kartik	Srawan	9
Mangsir	***Bhadra***	***10***
Poush	***Asoj***	***12***
Magh	***Kartik***	***10***
Falgun	***Mangsir***	***11***
Chaitra	Poush	9
Baisak	Magh	8
Jestha	Falgun	7
Asar	Chaitra	5

The clear and dramatic seasonality of births in the terai offers unique opportunities for planning and implementing reproductive health and family planning services. For example, knowledge of the seasonal occurrence of large numbers of births, due to seasonal or marriage-month influences, can be used to anticipate demand for antenatal and obstetric care. On the other hand, intensifying family planning services just prior to and during the annual peak conception months of December and January could efficiently and effectively blunt the seasonal peak in conceptions and markedly lower the annual birth rate.

4

CHILD GROWTH



Children in the terai have long been known to be acutely and chronically malnourished with respect to protein, energy and key micronutrients such as vitamin A, iron and zinc (1). Anthropometry, involving the measures of weight, length or height and mid-upper arm circumference, offers a way to assess the extent and degree to which young children are wasted (thin) and stunted (short). Stunting and wasting are typically considered to result from chronic and acute deficits, respectively, in protein and energy although poor growth can also be due, in part, to severe micronutrient deficiencies, parasite infection and nutritional stress of infection. Thus, there may be multiple causes of wasting and stunting that can be expected to vary in severity by age, sex, season and morbidity experience.

General nutritional status of children in Sarlahi was evaluated during NNIPS-1 by anthropometry. Nearly 4300 children from early infancy through 60 months of age in 40 randomly selected wards were measured at baseline (September to December, 1989) and every four months thereafter for two years. Children were measured for weight, length (<24 months), height (≥24 months) and left mid-upper arm circumference at each visit. These data provide a basis for describing the nutritional status (prevalence of malnutrition below established cut-offs), patterns of achieved growth (attained growth of children compared to WHO reference curves) and growth velocities of preschool children in the terai. In addition, all 38,337 children participating in the trial were assessed by mid-upper arm circumference at home every four months as a way to update their acute nutritional status and provide a basis for depicting the seasonality of wasting malnutrition in the terai.

Prevalence of Malnutrition

Prevalence of wasting (low weight-for-height), stunting (low height-for-age) and wasting-plus-stunting malnutrition among children under 6, 6-11 and 12 to 60 months of age during the peri-harvest time period of September to December (1989) are described in **Table 4.1**. The percentage of malnourished children can be determined by identifying the number whose nutritional status falls below a certain cutoff of the WHO reference population (2). The cutoff to define moderate-to-severe wasting and stunting has been set at two standard deviation units ("Z-scores") below the WHO reference medians for weight-for-height and height-for-age, respectively. Based on these indicators, 19.3% of younger infants and 43.0% of older infants are stunted in length or height; 3.2% and 10.9% are wasted at those ages, respectively. Among preschool children, 65.5% are stunted and 11.5% are wasted.

Table 4.1: Prevalence of Wasting and Stunting in children aged 0 - 60 months (1989)

***ages 0 – 5 months** (n = 378)*		
	Not Stunted	Stunted
Not Wasted	78.3%	18.5%
Wasted	2.4%	0.8%
***ages 6 – 11** (n = 412)*		
Not Wasted	50.5%	38.6%
Wasted	6.5%	4.4%
***ages 12-60 months** (n = 3484)*		
Not Wasted	31.4%	57.1%
Wasted	3.1%	8.4%

Arm circumference measurement provides an additional, somewhat age-independent measurement for assessing the prevalence of acute malnutrition among preschool children over 12 months of age. Conventional cutoffs for wasting are:

Middle upper arm circumference (MUAC) in centimeters	Status
>13.5	Normal
13.5 - 12.5	Moderate wasting
<12.5	Severe Malnutrition

By this indicator, 16.2% of children aged 12-35 months and 3.0% of children 36 months and older are moderately-to-severely wasted (below 13.5 cm) during the peri-harvest season. However, there is considerable seasonality to acute nutritional status (**Figure 4.1**), with children being best nourished during the post-harvest months of January - March and May - June, and least nourished in the pre-harvest months of October through December.

Achieved Growth

Figures 4.2 to 4.4 provide cross-sectional patterns of growth among children in Sarlahi in terms of their achieved length or height, weight, and arm circumference by age. Local distributions are compared to WHO reference curves, depicted at 97th, 50th (median) and 3rd percentiles at each age (3). Newborns' heights are approximately normal through the first 3-4 months of age (**Figure 4.2).** From 4-12 months of age, however, the heights from the Sarlahi and WHO populations diverge appreciably. At one year of age and thereafter, children representing the local median track below the 3rd percentile of the WHO reference population and children representing the 97th percentile in Sarlahi closely track the WHO 50th percentile. The stability of the growth curves after age 12 months suggests that linear growth stunting occurs primarily in the first year of life, with a low incidence in the later preschool years. Weight-for-age (**Figure 4.3**) shows a pattern that is similar to growth in height, with over 97% of Sarlahi child weights below the WHO reference median.

This difference between local heights and weights and the WHO reference data has been found in many developing country populations. Reasons that have been identified for growth faltering in later infancy focus on the onset of weaning. Weaning foods may often be less nourishing than breast milk, particularly for children below 12 months of age (Chapter 5). Furthermore, reduced consumption of breast milk lowers the immunological protection that maternal antibodies can provide. Therefore, children are more susceptible to infection (see also Chapter 6) and at the same time must adjust to rapid changes in their diets. Greater infection rates and poorer diets together reduce the amount of nutrients available for growth. Over a long term, child growth falls below the potential represented by the WHO reference population (1).

The pattern of age-related change in mid-upper arm circumference (**Figure 4.4**), reflecting wasting malnutrition, reveals a marked flattening of the curve at approximately 13 cm by the seventh month of life that remains constant through approximately 24 months of age. Arm circumference increases gradually during the second and third years of life before the local median levels off at approximately 14 cm for the remaining preschool years. In contrast, **Figure 4.4** also depicts the *5th percentile* of arm circumference values from the American reference population (obtained from the National Center for Health Statistics). The notable degree of wasting malnutrition in the terai is evident from the local 50th percentile values tracking *below* the 5th percentile of the NCHS reference.

Figure 4.1 Seasonal Variation in MUAC

Children aged 6 – 72 months
Sarlahi District, 1989 – 1990

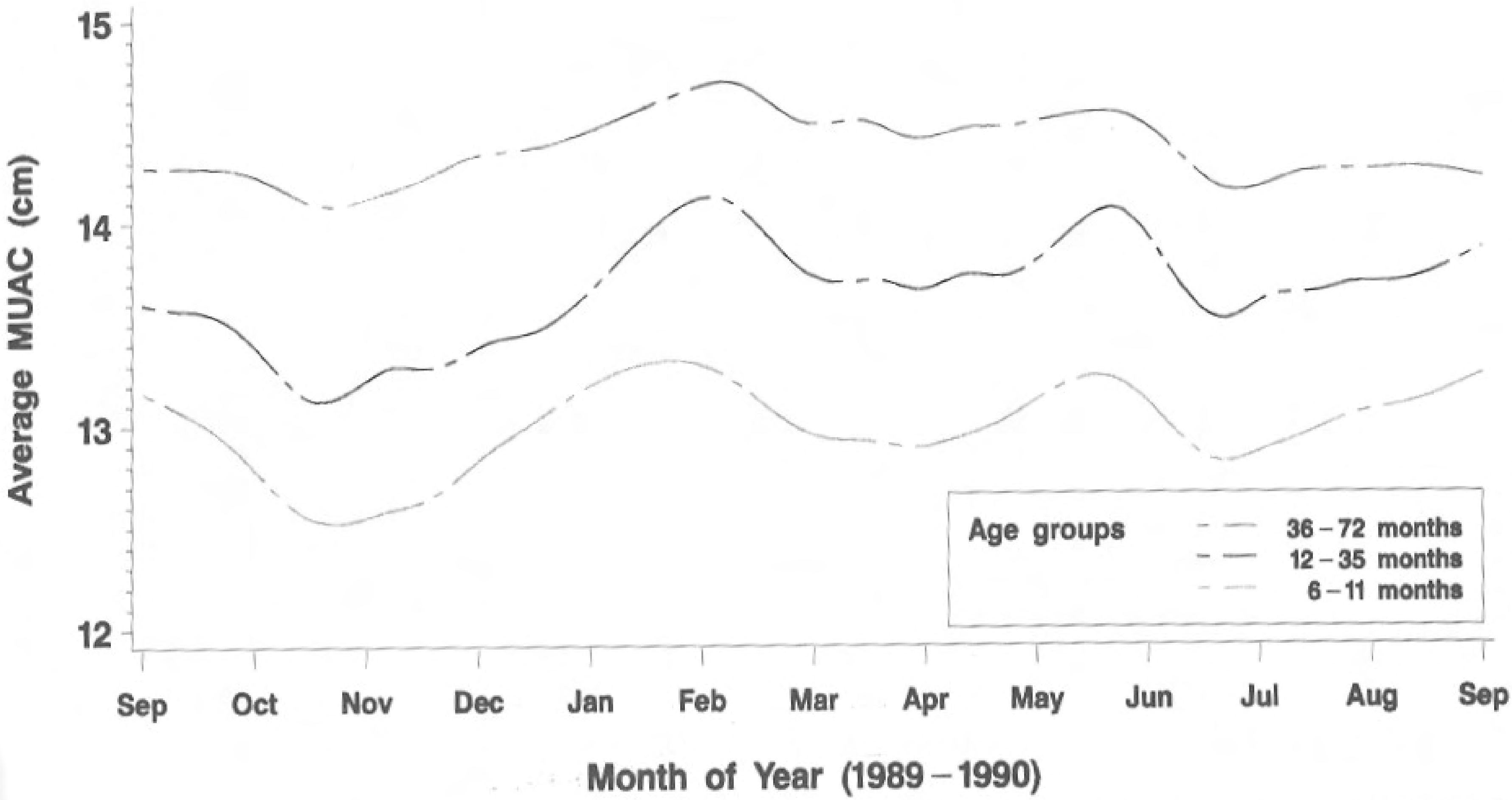


Figure 4.2

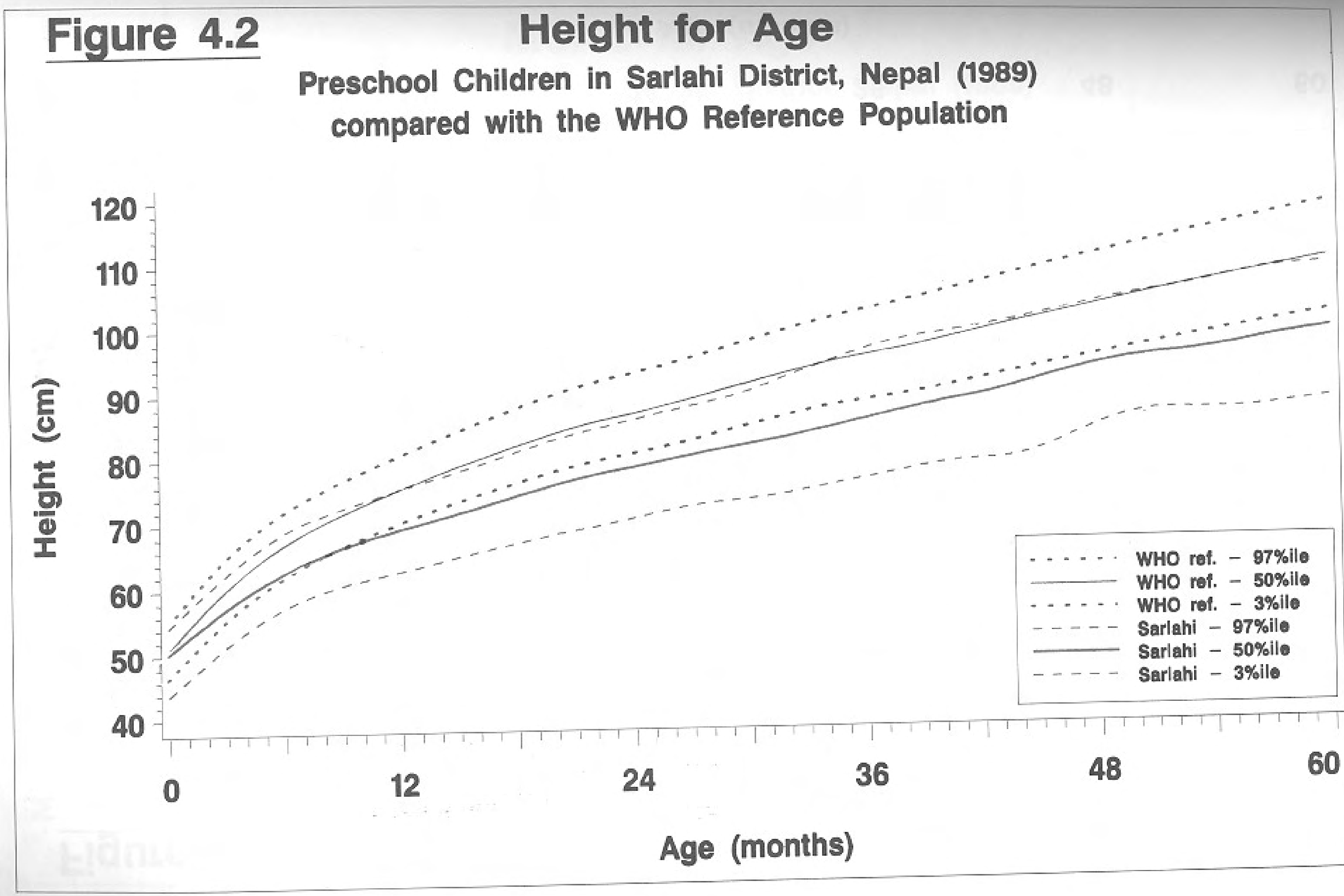
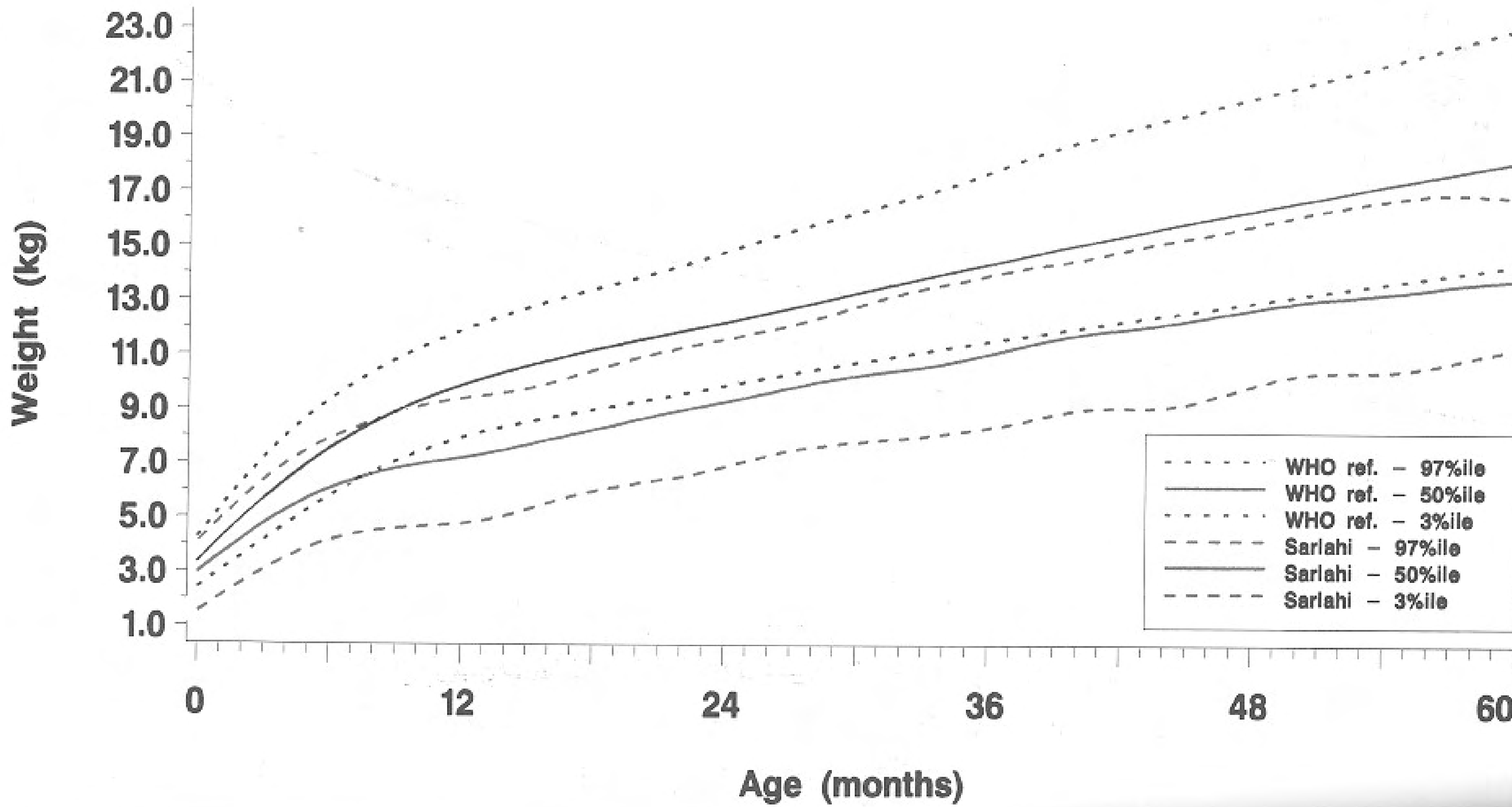

Height for Age
Preschool Children in Sarlahi District, Nepal (1989)
compared with the WHO Reference Population
Height (cm)
120
110
100
90
80
70
60
50
40
0
12
24
36
48
60
Age (months)
WHO ref. – 97%ile
WHO ref. – 50%ile
WHO ref. – 3%ile
Sarlahi – 97%ile
Sarlahi – 50%ile
Sarlahi – 3%ile

Figure 4.3

Weight for Age

Preschool Children in Sarlahi District, Nepal (1989) compared with the WHO Reference Population



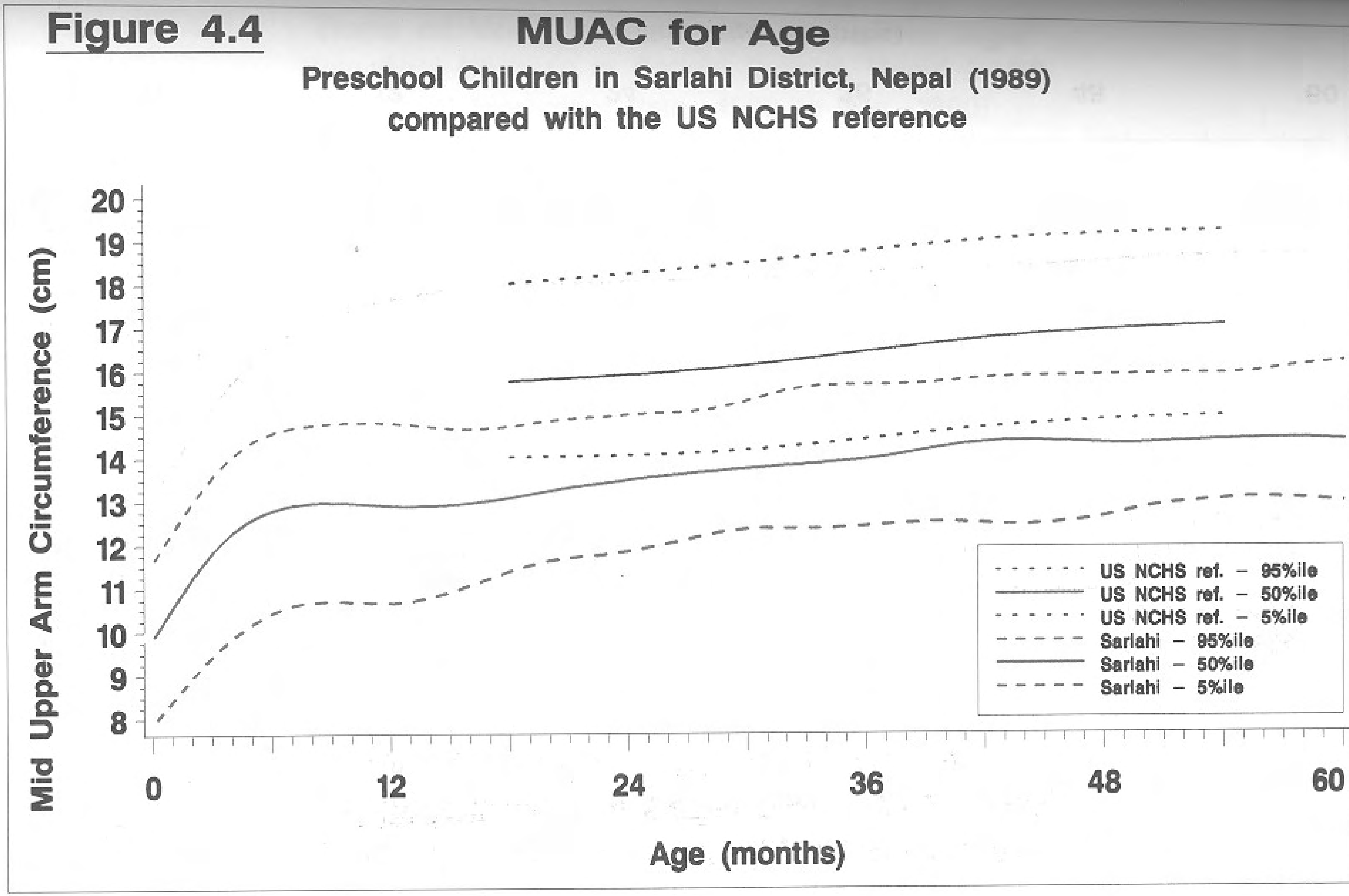


Figure 4.4
MUAC for Age
Preschool Children in Sarlahi District, Nepal (1989)
compared with the US NCHS reference
Mid Upper Arm Circumference (cm)
20
19
18
17
16
15
14
13
12
11
10
9
8
0
12
24
36
48
60
Age (months)
US NCHS ref. – 95%ile
US NCHS ref. – 50%ile
US NCHS ref. – 5%ile
Sarlahi – 95%ile
Sarlahi – 50%ile
Sarlahi – 5%ile

Figure 4.5 Rate of Linear Growth by Baseline Age
Preschool Children in Sarlahi District, Nepal (1989)
Annual Increment (late–1989 to late–1990)

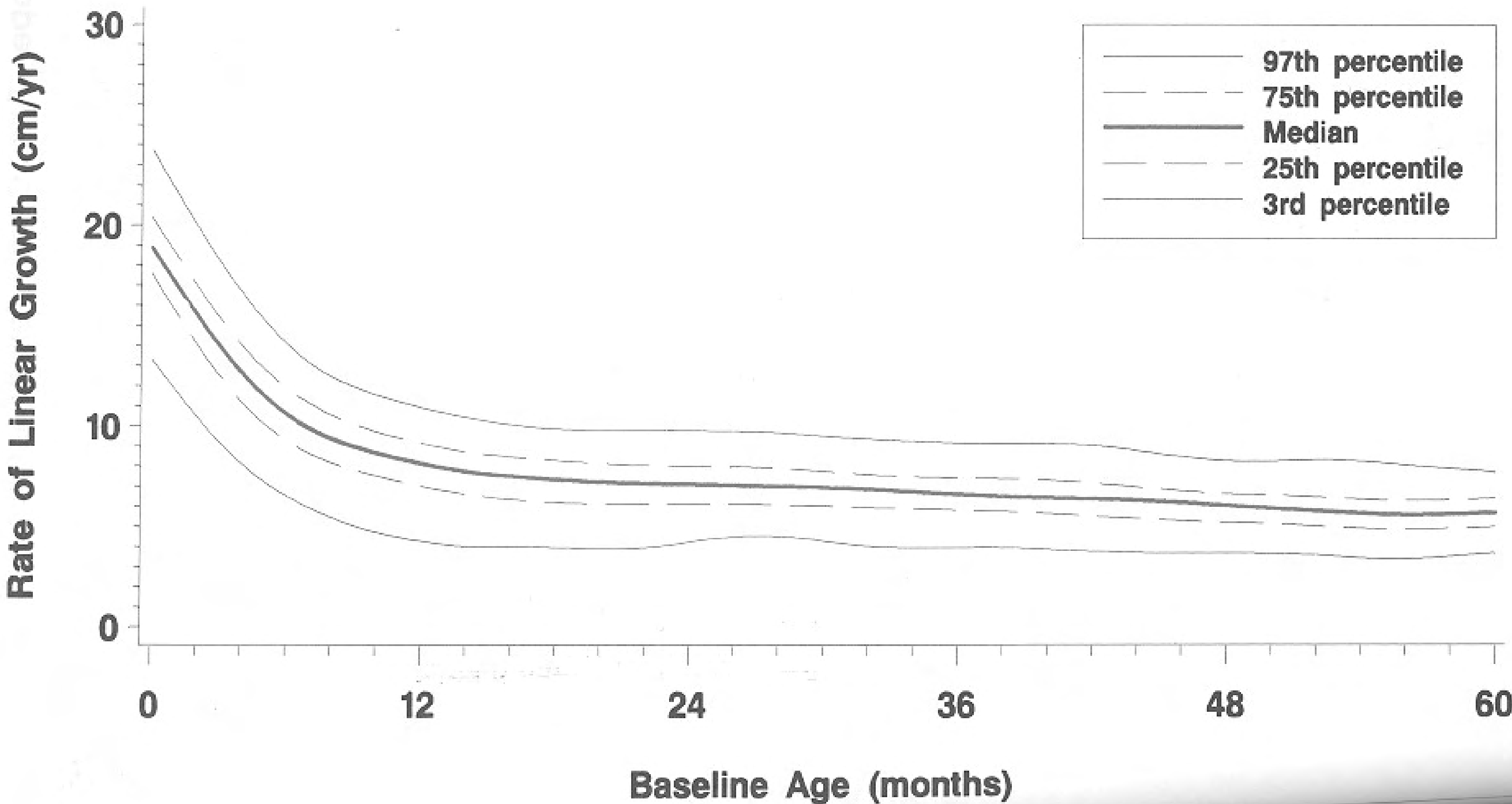


Figure 4.6 Rate of Weight Gain by Baseline Age
Preschool Children in Sarlahi District, Nepal (1989)
Annual Increment (late-1989 to late-1990)

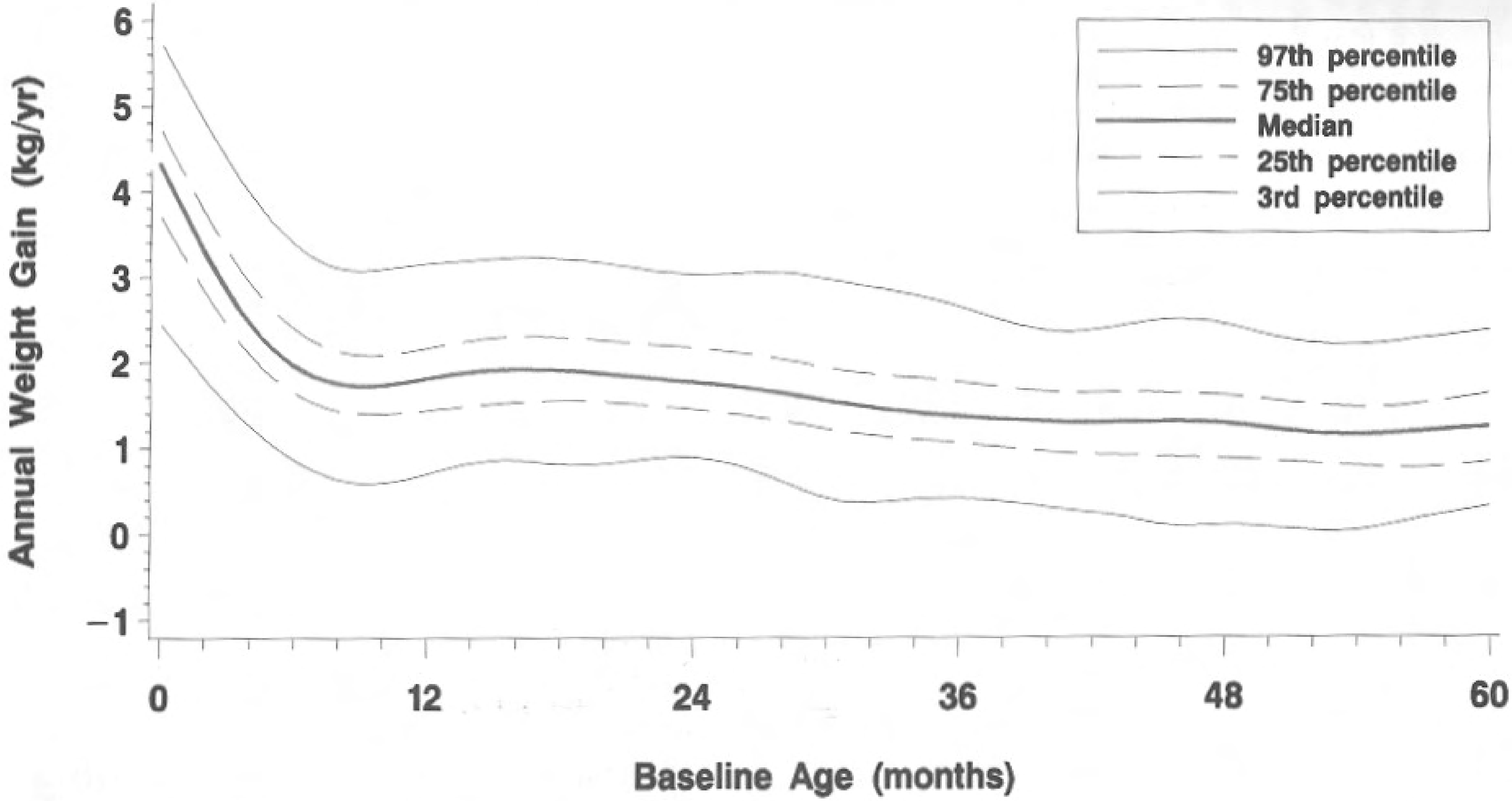
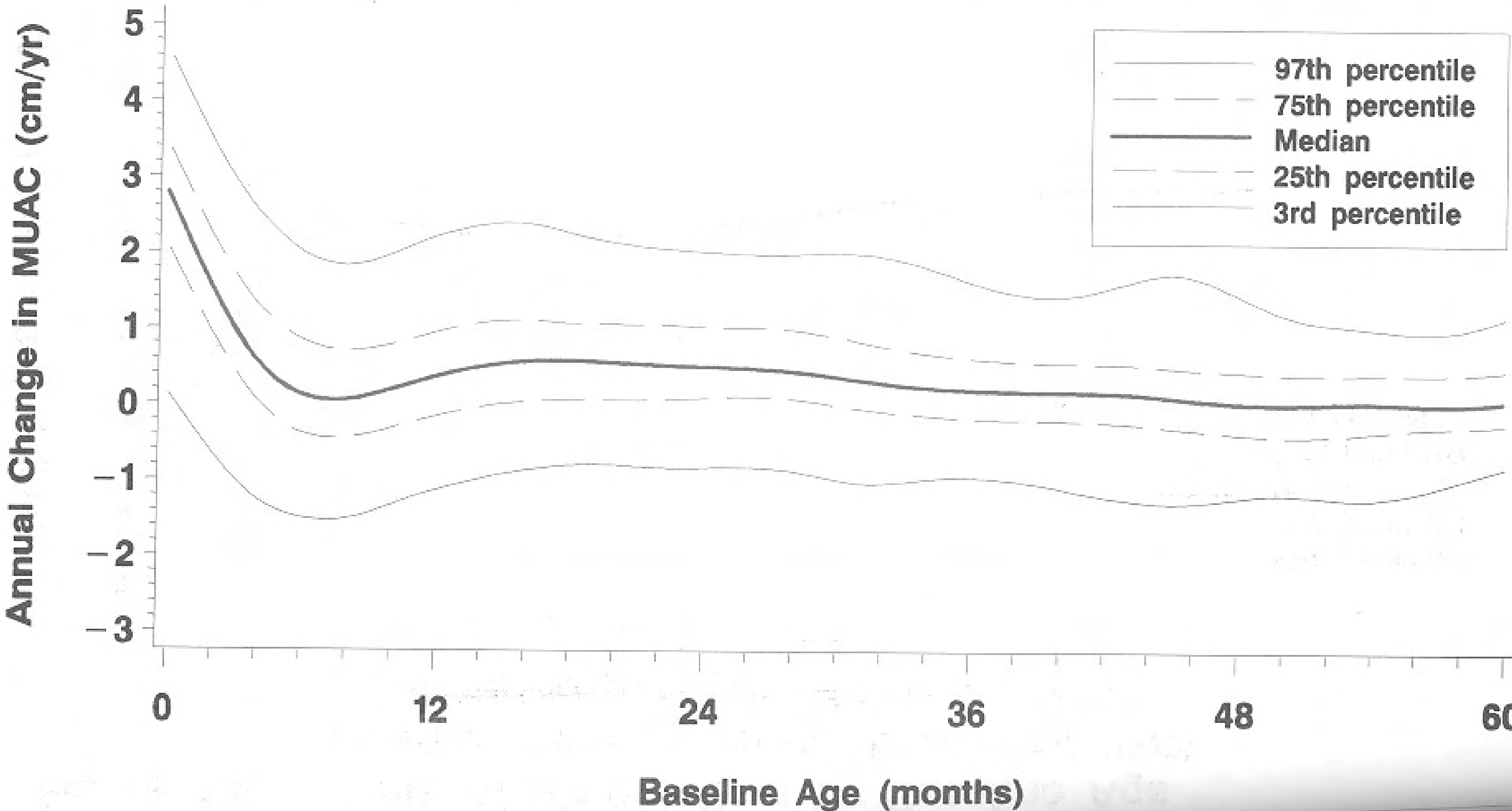


Figure 4.7 **Rate of MUAC Growth by Baseline Age**

Preschool Children in Sarlahi District, Nepal (1989)

Annual Increment (late–1989 to late–1990)



Velocity of Growth

Growth velocity represents change in size over a specified time period. Twelve-month growth velocities for linear (length or height), ponderal (weight) and arm circumferential growth by age are displayed for infants and children in Sarlahi in **Figures 4.5 to 4.7**. Such annual growth velocities are seasonally adjusted by virtue of their 12-month duration.

Neonates grow, on average, 19 cm in length during the first year (**Figure 4.5**). Infants who are six months of age grow approximately 10 cm in length over their next 12 months of life. By 12 months of age, children can be expected to exhibit an annual growth rate of approximately 8 cm per year. From 18 - 36 months, the median rate of linear growth among children in Sarlahi is approximately 7 cm per year, and thereafter stabilizes at approximately 6 cm per year throughout the remaining preschool years.

Weight gain is most rapid in the first six months of life (**Figure 4.6**). Newborns gain, on average, 4.3 kg over their first year of life, although half of all newborns gain less than this amount. For example, the slowest growing infants (i.e., those growing along the local 3rd percentile) put on only 2.4 kg in their first year of life. Six-month old infants gain an average of 2.0 kg per year, an annual rate that equally applies to children through 24 months of age. Thereafter, children in Sarlahi gain approximately 1.5 kg per year up to age 36 months and 1.25 kg per year from ages 36 to 60 months.

Rates of gain in arm circumference show a pattern similar to that for weight gain. The average neonate in Sarlahi increases its arm circumference by 3.0 cm during the first year **(Figure 4.7)**. By six months, arm circumferential growth has slowed to only approximately 0.4 - 0.6 cm per year. In the latter half of infancy, over 25% of infants in the terai actually experience a *decrease* in arm circumference, representing a loss in arm fat and increased use of energy stores to support growth. The 0.4 to 0.6 cm annual gain in MUAC extends through the second and third years of life, after which age preschool rural children in the terai have negligible growth in arm circumference of - 0.1 to + 0.2 cm per year.

Vitamin A and Child Growth

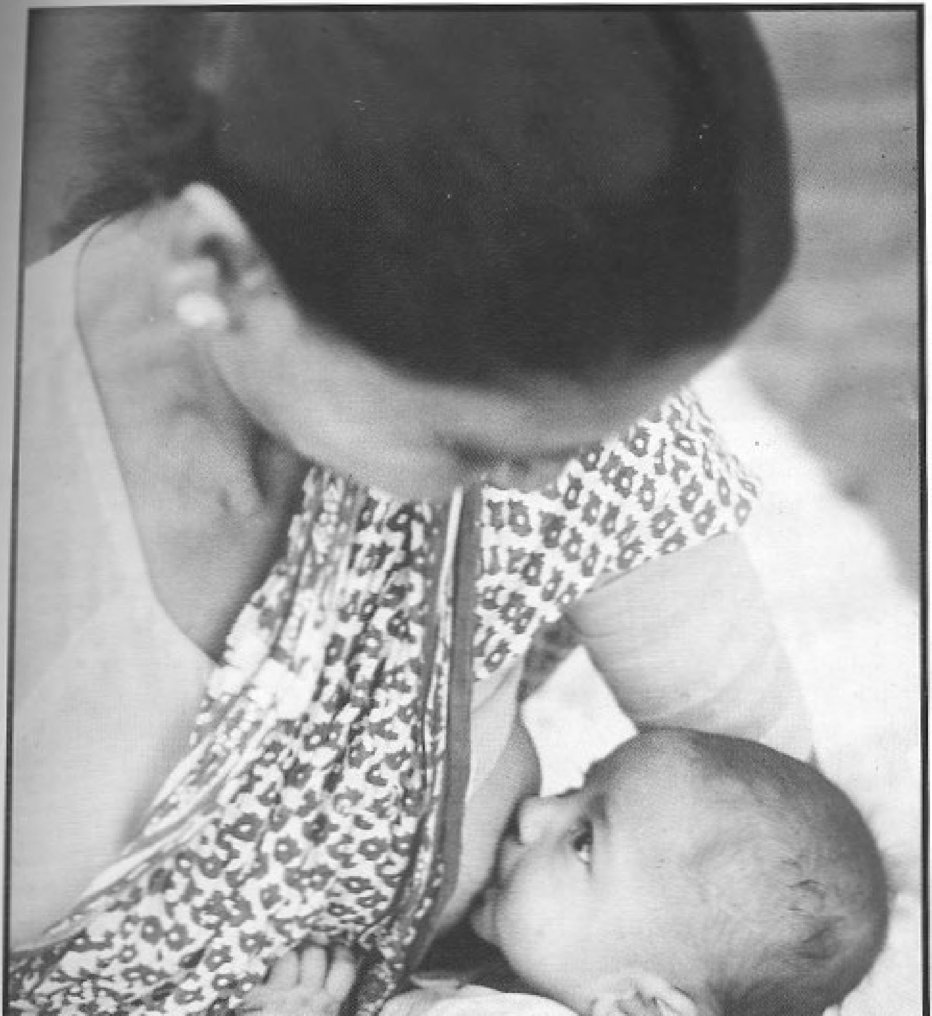
NNIPS-1 showed that moderate to severe vitamin A deficiency, marked by the presence of xerophthalmia, can restrict preschool child growth. Children with night blindness or Bitot spots who were also thin by middle-upper arm circumference at the outset and who were treated with at least 400,000 IU of vitamin A, gained more in weight (by approximately 670 g), height (by approximately 1 cm), in arm muscle and fat areas (by 76 and 79 mm, respectively) and trunk fatness than non-xerophthalmic but equally thin children. Less severe vitamin A deficiency did not affect growth but influenced body composition. That is, vitamin A dosing of children without any signs of xerophthalmia improved arm muscle mass without gains in height or weight (4).

In summary, infants in Sarlahi exhibit vigorous but rapidly decelerating growth during their first 4-6 months of life. Thereafter, growth decelerates to a nearly constant annual rate for height, weight and arm circumference after the first year of life. The timing of significant growth failure, among children from 4-12 months of age in Sarlahi, relates directly to the age at which universally breast fed infants (see Chapter 5) (a) are often routinely begun on complimentary foods that are likely inadequate in energy, protein and essential nutrients and (b) face increased exposure to environmental pathogens and risk of diarrhea and other common childhood infections (see Chapter 6), including measles.

See Appendix IV for tables giving growth data for Sarlahi children.

5

BREAST FEEDING



Virtually all infants are breast fed during the first year of life in the terai. **Table 5.1** illustrates the prevalence of breast feeding by age among a subsample of approximately 4800 children at baseline. 99.8% of surveyed infants under six months of age were breast fed, as were 98.5% of infants 6-11 months and 92% of children during the second year of life. Children tend to be weaned in their third and fourth years of life during which 50% and 22%, respectively, of children in Sarlahi were still being (partially) breast fed. The small percentages of children still being breast fed at ages 4 and 5 years may represent extended feeding from birth and/or shared breast feeding with younger siblings.

Table 5.1: Breast feeding of Children by Age
n=4750

Age in months	Number of infants	Number Breast feeding (%)
0-5	487	486 (99.8)
6-11	461	454 (98.5)
12-23	945	867 (91.7)
24-35	949	475 (50.0)
36-47	937	202 (21.6)
48-60	971	53 (5.5)
Total	4750	3477 (73.2)

As seen in **Figure 5.1**, 75% of infants breast feed $\geq$10 times per day in the first few months of life. The percentage feeding at this rate declines steadily until 5 years of age when it reaches 0. The percentage of children feeding <10 times per day is 25% in early infancy, although this pattern characterizes the majority of children (50%) by three years of age. Changes in the rate of breast feeding over time represent natural attrition associated with weaning children from the breast through the first few years of life.

Figure 5.1

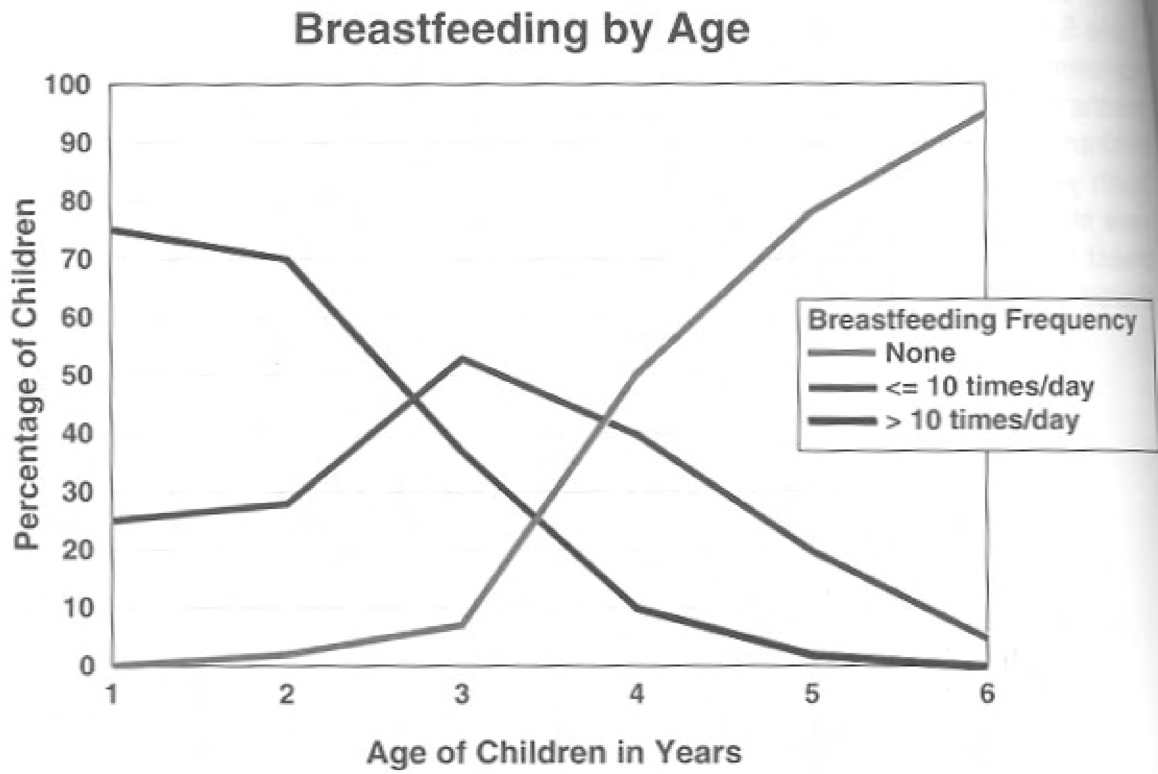


Table 5.2: Mean Weight (kg) and Height (cm) of Children 12 - 60 Months by Breast Feeding Status

(Adjusted for age within age category)
n=3457

Age months	Number	No Breast Feeding (%)	Mean Weight	*Height*	≤ 10 x per Day (%)	Mean Weight	*Height*	>10 x per Day (%)	Mean Weight	*Height*
12-23	847	9%	**8.4**	*73.8*	53%	**8.0**	*73.1*	38%	**7.7**	*72.4*
24-35	859	56%	**10.4**	*81.2*	41%	**10.0**	*80.9*	9%	**9.5**	*80.0*
36-47	849	78%	**12.1**	*88.6*	20%	**11.7**	*87.9*	2%	**10.9**	*85.0*
48-60	902	94%	**13.5**	*95.8*	6%	**12.5**	*92.7*	0%	---	---

Breast Feeding and Growth of Infants

The effect of breast feeding on growth is shown in **Table 5.2**. Nearly all infants (99%) are breast fed during the first year of life. Lack of breast feeding is associated with poor growth. Partial weaning begins at around 6 months of age.

Beginning at approximately 12 months of age there appears to be a small, detrimental effect on **weight** with increased breast feeding. Among children 12-23 months of age, there is a decrease of roughly .4 kg in mean weight as breast feeding increases by category (none, ≤ 10 x/day, >10 x/day). Among children 24-36 months, those not breast feeding are on average .4 kg heavier than those who breast feed <10 times per day, and .9 kg heavier than those who breast feed ≥ 10 times per day. At the age of 36-47 months, only 22% of children still breast feed. The majority of those breast feed <10 times per day, and they are an average of .4 kg less in weight than children who are completely weaned at this age. 94% of children from ages 48-60 months do not breast feed; among the remaining 6%, there is decrease of 1.0 kg in mean weight.

From the ages of 12-60 months, there is a parallel pattern of slightly decreased mean *height* in children who breast feed, compared to those that do not. The impact on height is much smaller than on weight, however. Among children 12-23 months of age, there is a decrease of .7 cm in height for those who breast feed <10 times per day, compared to those completely weaned. Likewise, those who breast feed ≥ 10 times per day are on average .7 cm less in height than those who breast feed less, and 1.4 cm less than those who do not breast feed. The 20% of children 36-47 months of age who breast feed (<10 times per day) are on average .7 cm smaller than those who do not breast feed. The 6% of children aged 48-60 months who breast feed are on average 3.1 cm smaller than those weaned.

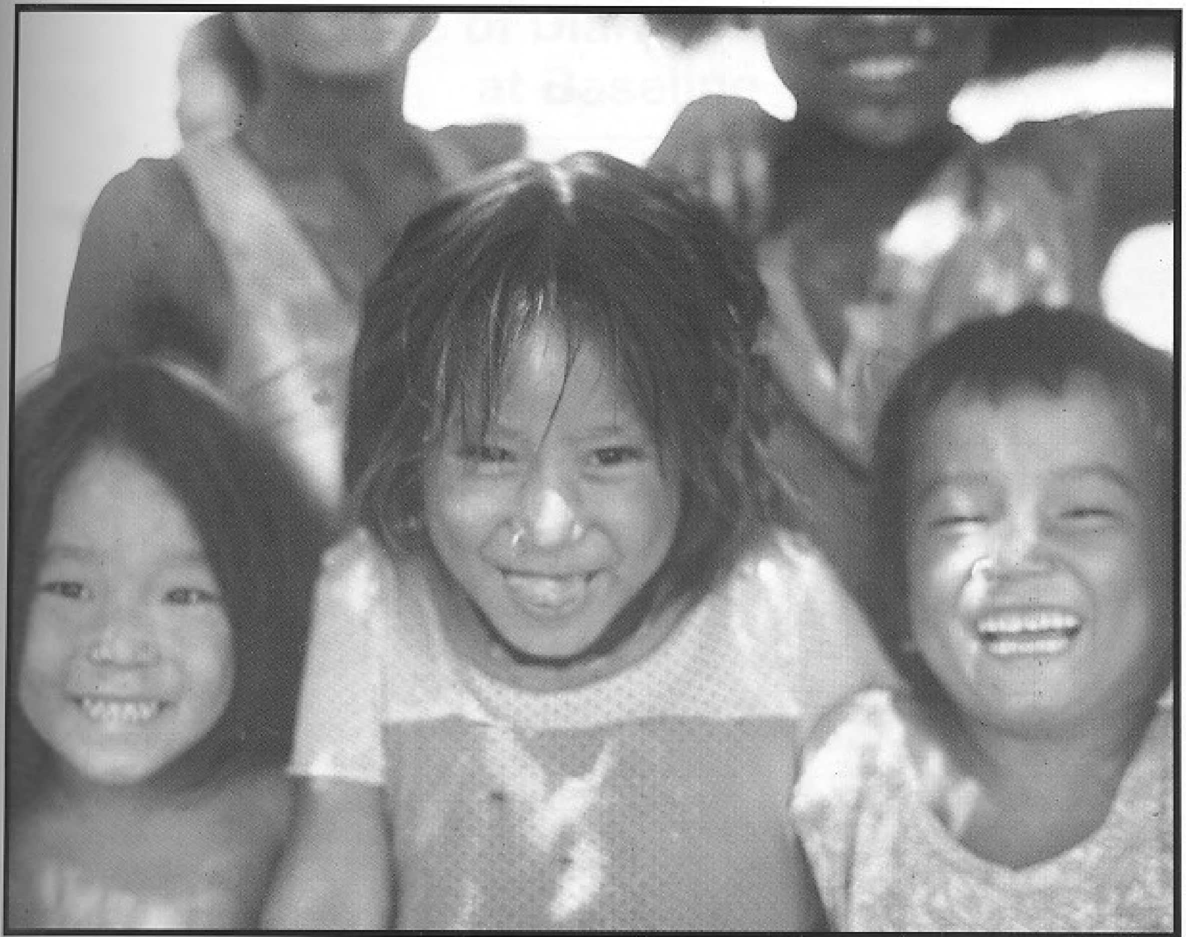
When these data are stratified by socio-economic status, the pattern remains the same. Children are slightly heavier and taller as socio-economic status increases, but there is a similar, consistent pattern of mean weight and height decreasing as breast feeding increases for children above 12 months of age (data not shown).

An explanation for the increased growth of children who do not breast feed above 12 months of age may lie in the increased caloric density of foods and animal milk used to replace mother's milk. It may be also that children who continue to breast feed do not have the same appetite for other foods they need to grow as weaned children. Continued breast feeding into older ages may also be associated with children who are more sickly for other reasons, who thus tend to cling to their mother's breast instead of venturing forth to try new foods. Finally, breast milk does not have the nutrients required for child growth beyond a certain point in time.

In summary, breast feeding which continues past a weaning age of the second year of life is associated with slightly decreased weight and height, compared to children completed weaned. The more often the child breast feeds, the more marked is the association with decreased growth. Weight is effected more than height.

6

CHILD MORBIDITY



Frequent and severe infection places young children at a high risk of morbidity, poor growth and mortality. In NNIPS-1, data on the health of children was collected at each visit. A history was taken to determine the number of days in the past week the children had the following morbidities: diarrhea (≥ 4 loose, watery stools per day), dysentery (blood in the stool), fever ("hot to the touch"), cough, cough-plus-rapid breathing, and ear discharge.

Figure 6.1.a

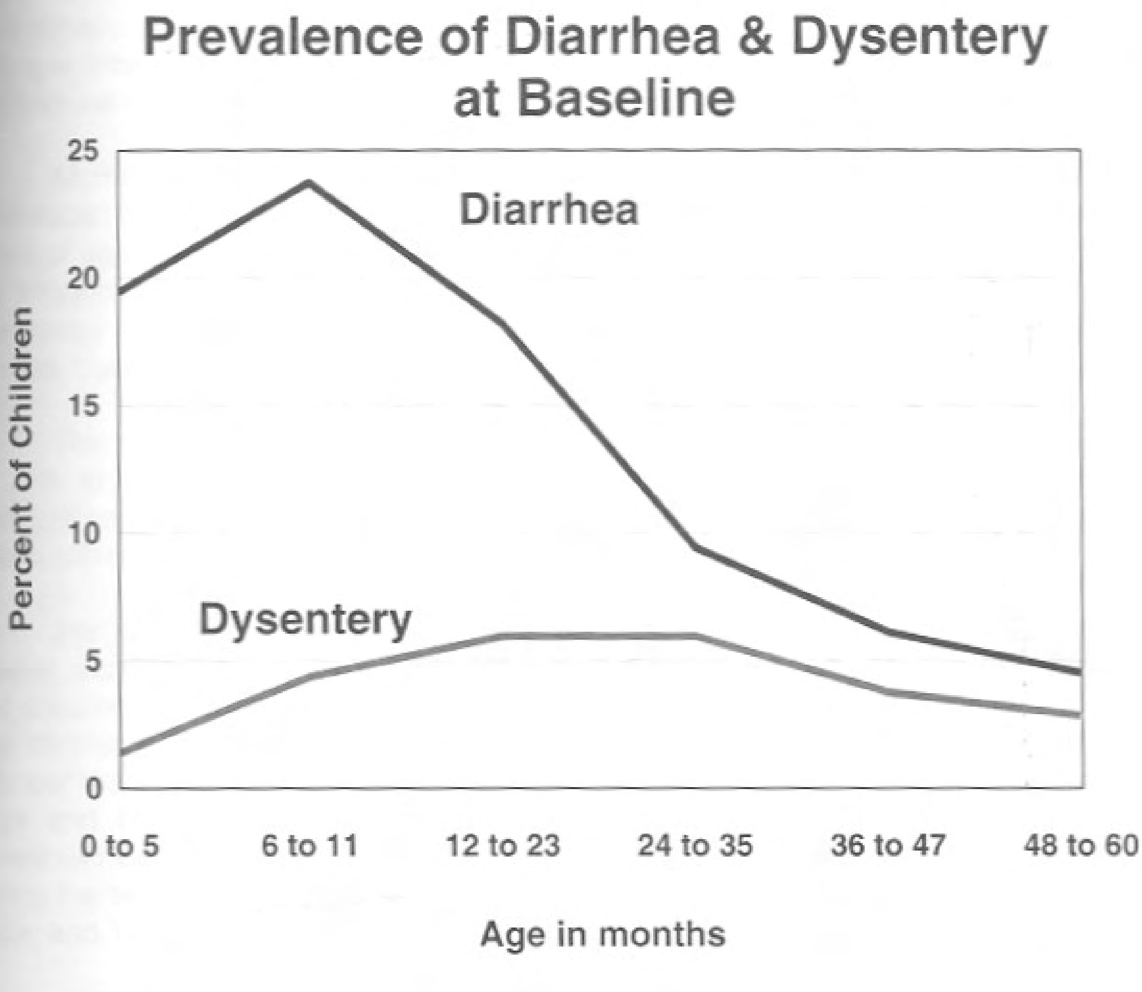


Figure 6.1.b

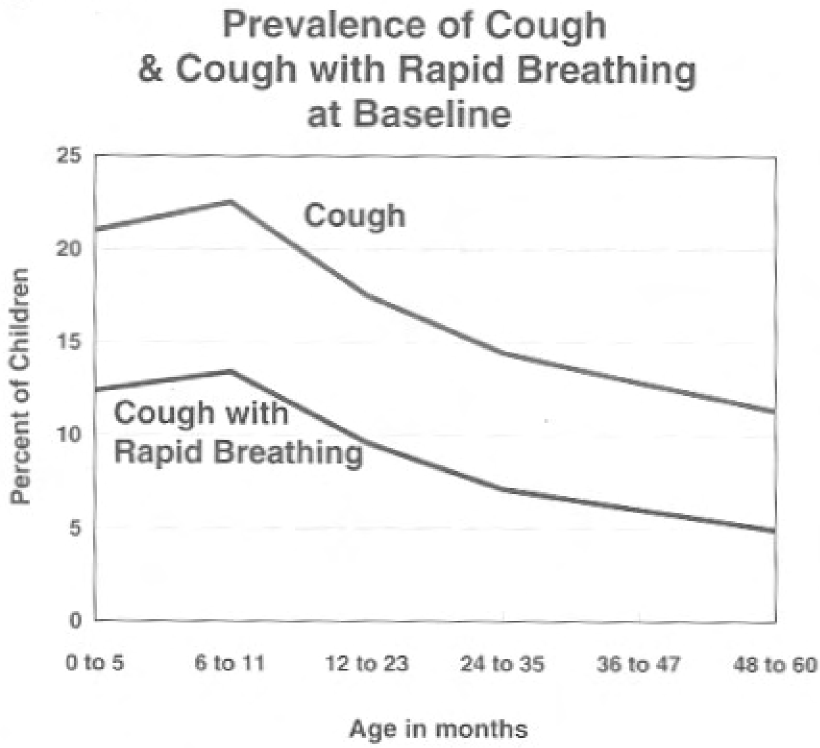
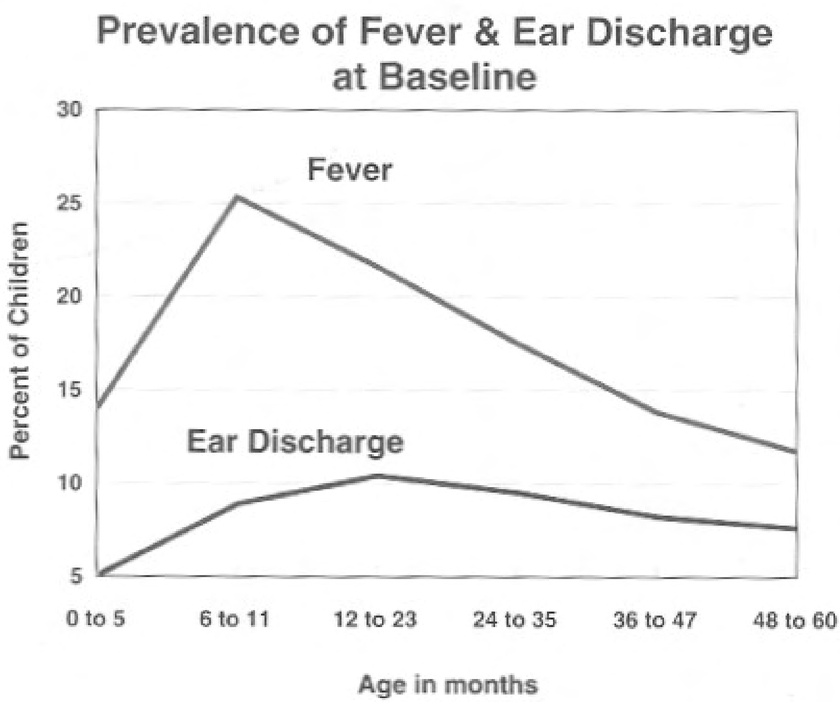


Figure 6.1.c



Prevalence of Morbidity

Panels a-c of **Figure 6.1**, show the weekly prevalence of morbid conditions by age, at baseline of NNIPS-1. The prevalence of diarrhea, fever, cough and cough with rapid breathing are highest among infants under one year of age. This may reflect the heightened exposure and susceptibility of immature host defenses to infection at this young age.

For example, 20% of infants below the age of 6 months and 24% of infants 6-11 months of age had at least one day of diarrhea during the previous week, reflecting probable increased exposure to unhygienic foods and other sources of contamination as infants begin to explore their home environment. Thereafter, the diarrhea rate falls, to 18%, 9% and 6% in the second, third and older years, respectively. Dysentery, by contrast, occurs less frequently, affecting only 1% of younger infants and approximately 5% or fewer of older infants and preschool children each week.

Mothers reported at least one day of cough in approximately 22% of infants. Thereafter, the frequency of cough steadily declined, to a prevalence of 11% by five years of age. The prevalence of cough with rapid breathing was approximately half as frequent as cough. However, these rates are exceedingly high for "lower respiratory infection". When a more rigorous definition of lower respiratory infection is used, based on 7 days of cough with rapid breathing, rates vary from 1 - 4%.

The prevalence of fever was high in the first 6 months of life (14%). It spiked to 25% in older infancy, possibly due to increased risk of infection during the weaning period, and then showed a steady decline through the remaining preschool years, affecting 12% of children in the fifth year of life.

Ear discharge, indicative of severe, chronic middle ear infection (otitis media), occurred in about 5% of infants under six months, and 10% of older infants and children in their second year. The prevalence declined only slightly thereafter. The chronic nature of otitis media is readily apparent from (a) the 71% of children with ear discharge at baseline who had the condition for all of the previous seven days and (b) the fact that ear discharge persisted until the next four-month household visit for 38% of all cases at baseline. Among children with ear discharge during the two year study, 30% had the condition for at least 2 consecutive 4-month visits, and 13% for 3 consecutive visits.

In summary, the first year of life is a period of time during which children are at highest risk for infection. In particular, the second six months of life represent a time of high risk of infection as weaning commences and infants are increasingly exposed to unhygienic conditions. This is also an age at which vitamin A supplementation begins to exert a strong, protective effect against severe infection and mortality (see Chapter 8). Most common morbid conditions decrease in frequency thereafter through the preschool years. With the exception of the highest rates of mortality in early infancy, the risk of child mortality generally parallels the age-specific patterns of observed morbidity (see Chapter 7).

Seasonality of Morbidity

In the terai there are four distinct seasons: (1) dry, cool, post-harvest (mid-December to mid-March); (2) hot, dry (mid-March to mid-June), (3) monsoon (mid-June to mid-September) and (4) pre-harvest (mid-September to mid-December). November and December mark the major rice harvest months of the year.

Figure 6.2

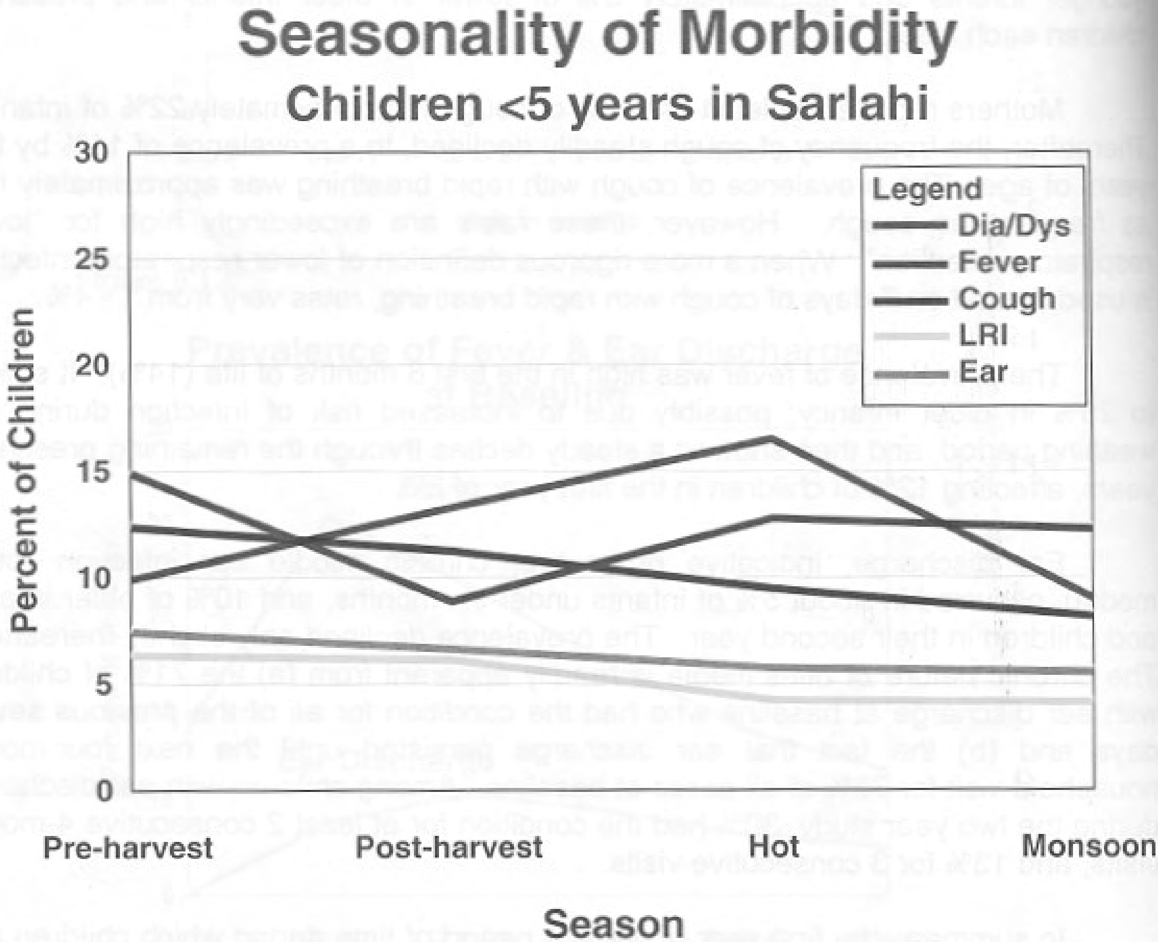


Figure 6.2 demonstrates the seasonal patterns of early childhood morbidity based on multiple rounds of household visits over a one year period. With the exception of diarrheal disease, there is a slight but consistent peak in symptoms of infectious morbidity in the pre-harvest period, which declines during the cool, post-harvest season. Poorer pre-harvest nutritional status may lower resistance to infection during this period. In contrast, generally adequate dietary intakes in the post-harvest period may enable children to better resist infection. For example, the

weekly prevalence of fever is 15% in the pre-harvest and 9% in the post-harvest seasons; cough affects 13% of children during the pre-harvest and 11% during the post-harvest seasons. Ear infection shows less seasonality (8% and 7%), probably because of its chronicity in children.

Diarrhea and dysentery follow a different pattern, peaking in the hot, dry, pre-monsoon season during which their (joint) weekly prevalence reaches 17%. Other recorded illnesses were lower in this season. During the monsoon, diarrheal disease fell, in this population, to almost half (9%) the pre-monsoon rate, possibly reflecting reduced diarrheal disease transmission during the rains. Otherwise, diarrheal disease prevalence would be expected to be higher because general nutritional status is not optimal during this time of year. These data contradict government figures (1) for Sarlahi which indicate a rise in diarrheal disease in these months, but are comparable to a decrease in diarrhea in the monsoon seen in Kathmandu (2). In our study population, the prevalence of cough and respiratory infection decline slightly during the monsoon.

Morbidity and Childhood Risk of Mortality

The remarkable value of a one-week morbidity history in predicting mortality risk can be seen in NNIPS-1 data. One can compare the mortality risk associated with the number of days children were reported to have these morbidities, relative to the risk of death among children who did not report these symptoms (i.e., relative risk, or RR). **Figures 6.3.a-f** describe the relative risk of death by level of weekly morbidity reported in children 4 months prior to their death. The graphs depict the mortality per 1000 child-visits for children reporting 0, 1-6 days or 7 days of an illness symptom, among children receiving placebo or vitamin A supplements every four months during the NNIPS-1 field trial. Adjusting the findings for age and sex had no discernable effect on the observed results in **Figures 6.3.a-f**.

Figure 6.3.a

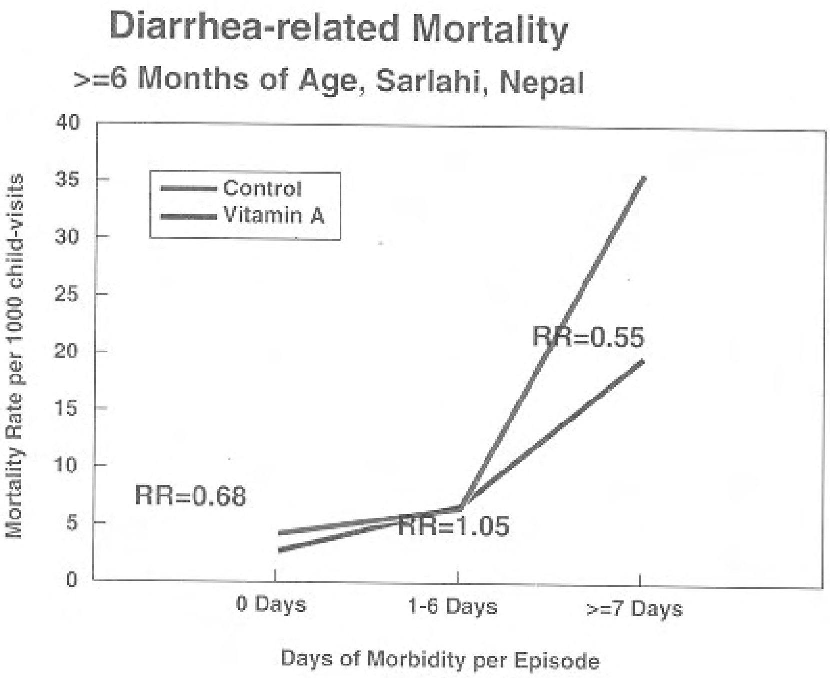


Figure 6.3.b

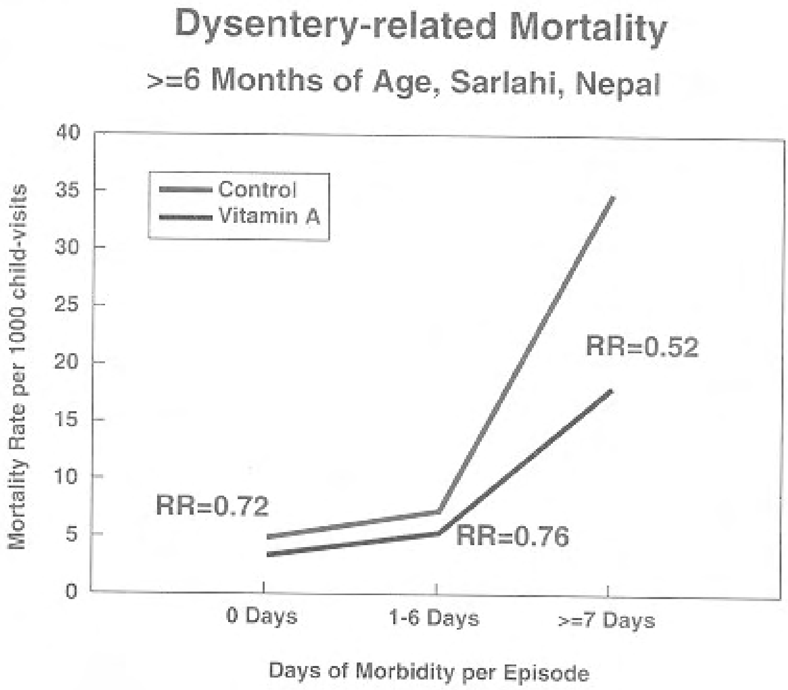


Figure 6.3.c

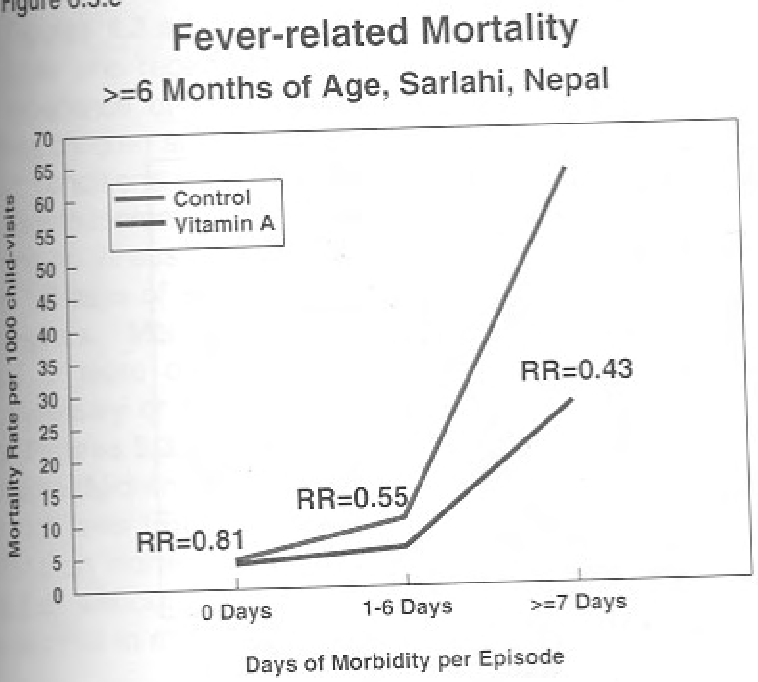


Figure 6.3.d

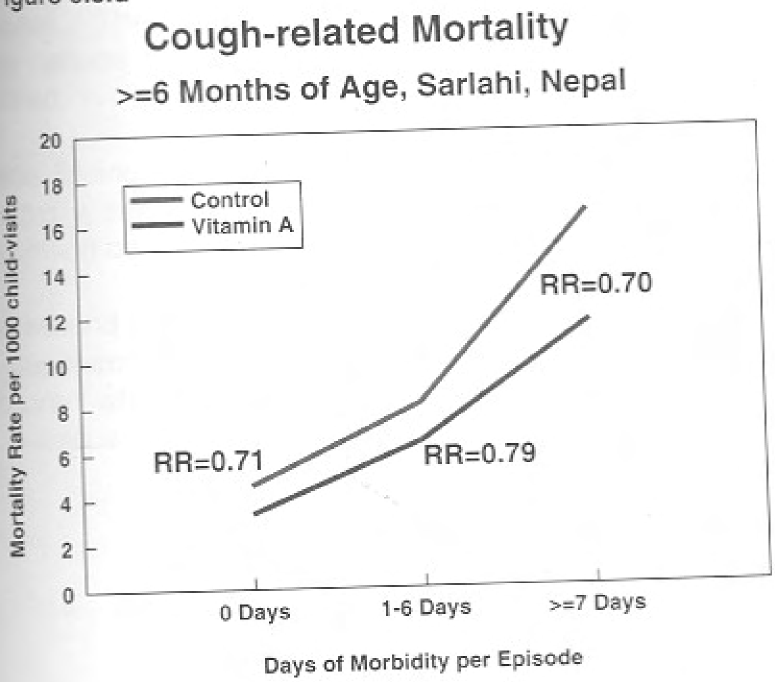


Figure 6.3.e

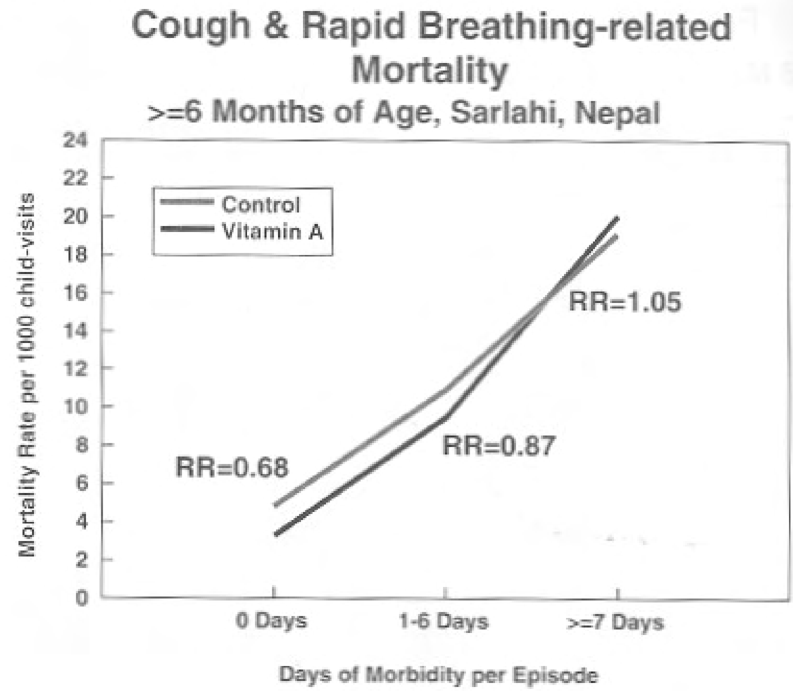
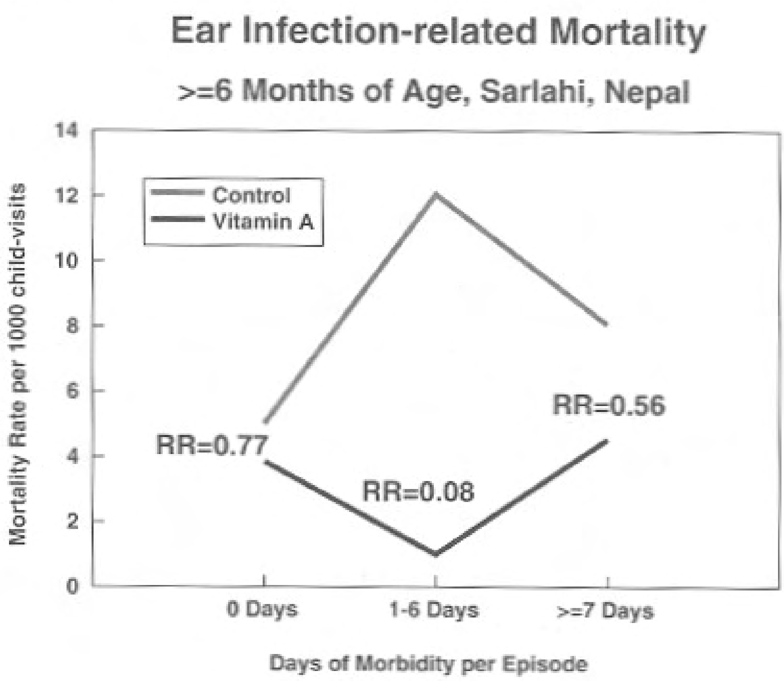


Figure 6.3.f



In **Figures 6.3.a-f**, the red line represents children in the *placebo control group* – those who received no vitamin A during NNIPS-1. The morbidity and mortality experience of these children represents that of the child population at large. These children are considered in the following observations: For five of the six morbid conditions (all except ear infection), the risk of child death rose dramatically with increasing numbers of days children were ill. The mortality rate for children with no illness was approximately 15 deaths per 1000 child-years, while those with 1-6 days of an illness died at a rate of approximately 21-36 deaths per 1000 child-years. Moreover, the risk of death was much higher among children reporting 7 or more days (indicating a more severe and chronic condition) of diarrhea, dysentery or high fever. Mortality associated with 7 days of diarrhea or dysentery (**Figures 6.3.a, 6.3.b**) was 111 per 1000 child years, approximately 8-fold greater than in children who had no diarrhea or dysentery. Mortality associated with 7 days of high fever (**Figure 6.3.c**) was 192 per 1000 child years, approximately 13-fold greater than mortality in children with no fever. Seven or more days of cough (**Figure 6.3.d**), without or with rapid breathing (**Figure 6.3.e**), was associated with a less dramatic rise in mortality risk, to approximately 54 deaths per 1000 child years.

In contrast, mortality following an ear infection (**Figure 6.3.f**) was highest for children with *less* than 7 days of discharge. One to six days of ear discharge presumably represents acutely ill children whose ear drums had perforated the previous week. The lower mortality seen with 7 or more days of ear discharge presumably reflects the chronicity of, and *adaptation* to, middle ear infections in young children.

These findings suggest that a lay worker, carefully asking questions about weekly morbidity, can identify children at high risk of death and in need of immediate health or nutrition care and/or referral.

The second thing we observe from **Figures 6.3.a-f** relates to the efficacy of vitamin A supplementation in dramatically lowering mortality risk, by half or more, among children who were ill the week before a household visit. This impact of vitamin A is discussed in Chapter 8.

7

CHILD MORTALITY

Vital status of children participating in NNIPS-1 was updated every four months. As a result, mortality rates of children in the placebo-control group of the trial can be taken to represent the mortality experience of children under usual conditions in the terai.

By Age

Table 7.1 shows the mortality experience of a cohort of 264 infants in the control group whose vital events were followed for an entire year. The *observed* infant mortality rate (IMR) in Sarlahi was 114 deaths per 1000 live births. This rate is in agreement with published infant mortality rates for Nepal in the late eighties and early nineties.

Table 7.1: Infant Mortality
n=264

Age at enrollment	No. of infants	No. of deaths	Mortality rate per 1000 live births
0 months	264	30	114

Table 7.2 shows the mortality rates for children in the control group who were 6 to 72 months of age during the NNIPS-1 trial (1). Deaths are reported per 1000 child-years of follow-up. "Child-years" provides a convenient count of full, equivalent years of observation contributed by children during the 12-month period. The mortality rate of older infants was approximately 36 deaths per 1000 child-years of follow-up. Children in their second year died at a rate of 27.5 deaths per 1000 child-years; thereafter, mortality rates declined to 10-12 per 1000 child-years at ages 2-4 years and approximately 4 per 1000 child-years among five-year olds.

Table 7.2: Mortality Rate of Terai Children 6-72 Months of Age*
n=14,143 children

Age (months)	No. of child-years	No. of deaths	Mortality rate per 1000 child years
6-11	1315	47	35.8
12-23	2725	75	27.5
24-35	2592	31	12.0
36-47	2633	28	10.6
48-59	2573	25	9.7
60-72	956	4	4.2

* from KP West, et.al., *The Lancet*, 1991 (1)

Summing the rates from infancy through age four years, based on the cohort estimate of 100, there is a 16% chance of terai children dying in the first five years of life, in the absence of vitamin A supplementation. This is equivalent to an under 5 year mortality rate of 160 per 1,000 live births.

The IMR of 114/1000 live births observed in NNIPS-1 indicates that infant mortality has fallen approximately 45% since the 1960 figure of 206/1000 estimated by His Majesty's Government of Nepal (2). Nonetheless, there remains much progress to be made. With an IMR of 114, infants in Nepal die at 14 times the rate of infants in the United States, where the infant mortality rate is 8/1000 (3).

By Sex

There exists a marked difference in mortality between boys and girls (**Table 7.3**). Between the ages of 6-72 months, the mortality rate in this population is 19.3/1000 child-years for girls and 13.6/1000 child-years for boys, representing a 42% greater risk of mortality in girls than in boys at this age. Vitamin A supplementation reduced this difference by more than half to a 19% differential (see Chapter 8).

Table 7.3: Mortality Rate by Sex in Terai Children 6-72 Months of Age*
n=14,143 children

Sex	No. of child-years	No. of deaths	Mortality rate per 1000 child-years
Female	6263	121	19.3
Male	6531	89	13.6

* from KP West, et.al., *The Lancet*, 1991 (1)

Causes of Death

Causes of child death in NNIPS-1 were derived from "verbal autopsy" interviews that were conducted with the parents of deceased children, usually within two months, to obtain information on illnesses and other events leading up to the child's death. Data from these interviews were independently reviewed by two physicians in Kathmandu who agreed on singular probable causes of death and multiple (if indicated) possible causes of death. Probable causes of death are summarized in **Table 7.4** for neonates and in **Figure 7.1** for infants and children aged 1-59 months. Data are given only for children in the placebo control group, as these children represent the child population at large, without any impact of vitamin A supplementation.

Table 7.4: Probable causes of neonatal death
n=73 infant deaths <1 month of age

Probable Cause	No. of deaths	Percent
Prematurity	38	52.1
SIDS	15	20.5
ALRI/Whooping Cough	6	8.2
Neonatal tetanus	5	6.8
Malnutrition	4	5.5
Diarrhea/dysentery	3	4.1
Congenital causes	2	2.7

Premature birth accounts for over half (52%) of all neonatal deaths, followed by sudden infant death syndrome (SIDS) which accounts for 20% of deaths in the first month of life. (A SIDS death in this context is one in which an apparently healthy infant, or one for whom there was no identifiable cause of death obtained in the verbal autopsy, suddenly died, often during the night). Acute lower respiratory infection (ALRI), diarrheal disease and malnutrition are probable causes of nearly a fifth (18%) of deaths in this age group. The remainder of deaths appear to be due to neonatal tetanus (7%) and congenital malformations (3%).

Figure 7.1

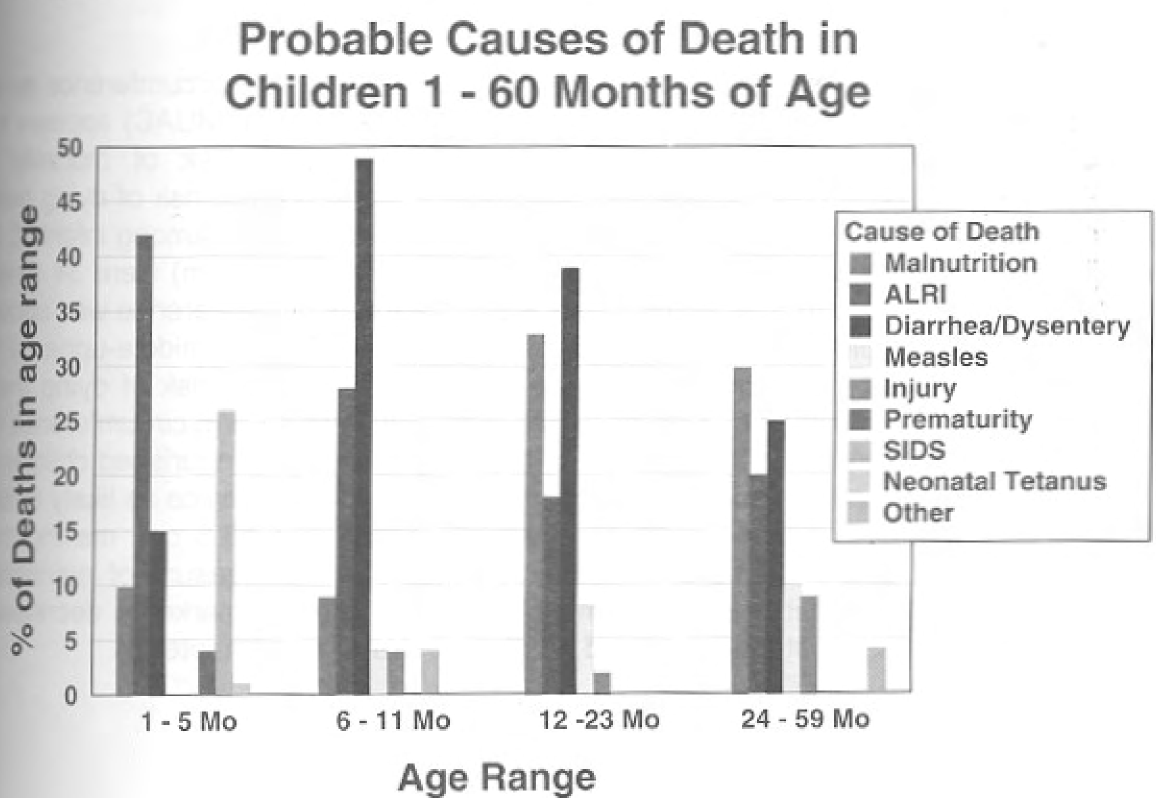


Figure 7.1 shows the probable causes of death in children 1-60 months of age in Sarlahi. The graph clearly highlights the three major causes of child death in this population. Acute lower respiratory infection (ALRI), diarrheal diseases (diarrhea and dysentery) and malnutrition take the lives of more children under 5 years of age than any other illnesses. Nearly half (42%) of deaths of infants 1-5 months of age are caused by ALRI. Half of deaths of infants 6-11 months of age are caused by diarrheal diseases. One third of deaths of children 1-5 years of age are due to malnutrition. These three illnesses combined account for 74% of deaths of infants 1-11 months, 90% of deaths of children in their second year of life, and 76% of deaths of children in their third to fifth years of life.

Other major causes of death include measles, which accounts for close to 10% of deaths among children 12-59 months. Injury is responsible for 10% of deaths among children 2-5 years of age and infectious diseases, such as meningitis, account for 2-4% of deaths in preschool children.

Malnutrition

While infectious diseases are often identified as leading causes of child mortality, wasting malnutrition plays a crucial role in predisposing children to fatality from illnesses. Based on verbal autopsy data, malnutrition was implicated as a probable cause in 22% of deaths of children 1-59 months, and was an underlying cause in many more. The excess risk of death associated with malnutrition can be seen by comparing the mortality rates of children with poor nutritional status (a small middle-upper arm circumference measured at the household visit prior to death) with those of better nourished children (**Table 7.5**).

Although debate exists about the relative merits of arm circumference as a measure of nutritional status, middle-upper arm circumference (MUAC) appears to provide a readily accessible means to assess childhood risk of mortality. Specifically, a wasted child, with a thin arm, is at a much greater risk of dying over the next four months than a child with an adequately sized arm. Among infants 0-5 months of age, those who were severely wasted (MUAC <8.5 cm) were 34 times more likely to die than infants of the same age whose arm circumference was above 12.5 cm. Among older children (12-72 months of age), a low middle-upper arm circumference (i.e., <11.5 cm) poses a nearly 60-times greater risk of dying than does an arm circumference of 13.5 or larger. Children with an arm circumference of 11.5-12.4 had a four-fold increased risk of mortality over better nourished children. Even those with an arm circumference between 12.5-13.4 were twice as likely to die than children with a middle-upper arm circumference over 13.5 cm, making the measurement of arm circumference a highly reliable, valid measure of nutritional status and child mortality risk. Vitamin A supplementation markedly decreased mortality risk across most MUAC-based nutritional strata (see Chapter 8).

Table 7.5: Child mortality stratified by arm circumference
n=278 (control group only)

Arm Circumference (cm)	No. of deaths	Child years	Mortality rate per 1000 child years	Relative risk of death
0-5 months of age:				
<8.5	32	72	444	*34.2*
8.5-10.4	37	439	84	*6.5*
10.5-12.4	19	951	20	*1.5*
≥ 12.5	9	688	13	*1.0*
6-11 months of age:				
<11.5 cm	14	132	106	*6.2*
11.5-12.4 cm	12	261	46	*2.7*
12.5-13.4 cm	8	392	20	*1.2*
>=13.5	6	346	17	*1.0*
12-72 months of age:				
<11.5	61	208	293	*58.6*
11.5-12.4	15	721	21	*4.2*
12.5-13.4	30	2132	13	*2.6*
>=13.5	35	6986	5	*1.0*

* from West KP Jr, et.al., *The Lancet*, 1991 (1), and West KP Jr, et. al, *Am J Clin Nutr*, 1995 (4)

8

VITAMIN A AND CHILD SURVIVAL

Vitamin A deficiency and its health consequences afflict young children throughout the terai and many hill areas of Nepal. Surveys over the past 15 years indicate that 1% to 13% of preschool children are at risk of developing xerophthalmia (1-7); however, 20% to 40% of children are likely to be subclinically vitamin A-deficient (8). This high prevalence, coupled with previous reports from Indonesia of increased morbidity (9) and mortality (10) among children with mild xerophthalmia and a one-third reduction in child mortality with community-based vitamin A supplementation (11), stimulated interest to determine the impact of vitamin A on child survival in Nepal.

The NNIPS-1 community trial was conducted to answer this important question. Over 30,000 children 72 months of age and younger were enrolled in 29 Village Development Committees, randomly assigned by ward to receive a large dose of vitamin A or a placebo supplement every four months at which time their vital status was checked.

Children 6 to 72 Months of Age

The findings provide clear evidence that the risk of mortality of Nepalese children 6 to 72 months of age can be reduced by approximately 30% when they are dosed with vitamin A (12). The impact was observed at each age and in both sexes (though the benefit was greater in girls) (**Table 8.1**). The reduction was also seen across all levels of nutritional status (measured by arm circumference every four months) and throughout the seasons of the year. The results at this age were so dramatic that the trial was halted after one year and children in the control group were switched over to receive vitamin A at the next 4-month round and thereafter.

Figure 8.1 describes the impact of vitamin A at all ages (above 6 months) during each 4-month interval. There was a 27% reduction in mortality after children received a single dose of vitamin A. Reductions during the next two 4-month intervals were 33% and 30%. During the interval between deciding to stop the trial and actually switching children in the control group to vitamin A there was a 26% reduction (13). Once control children began receiving vitamin A every four months, their mortality decreased to that of the original vitamin A group after two rounds. All of these mortality reduction figures are statistically significant.

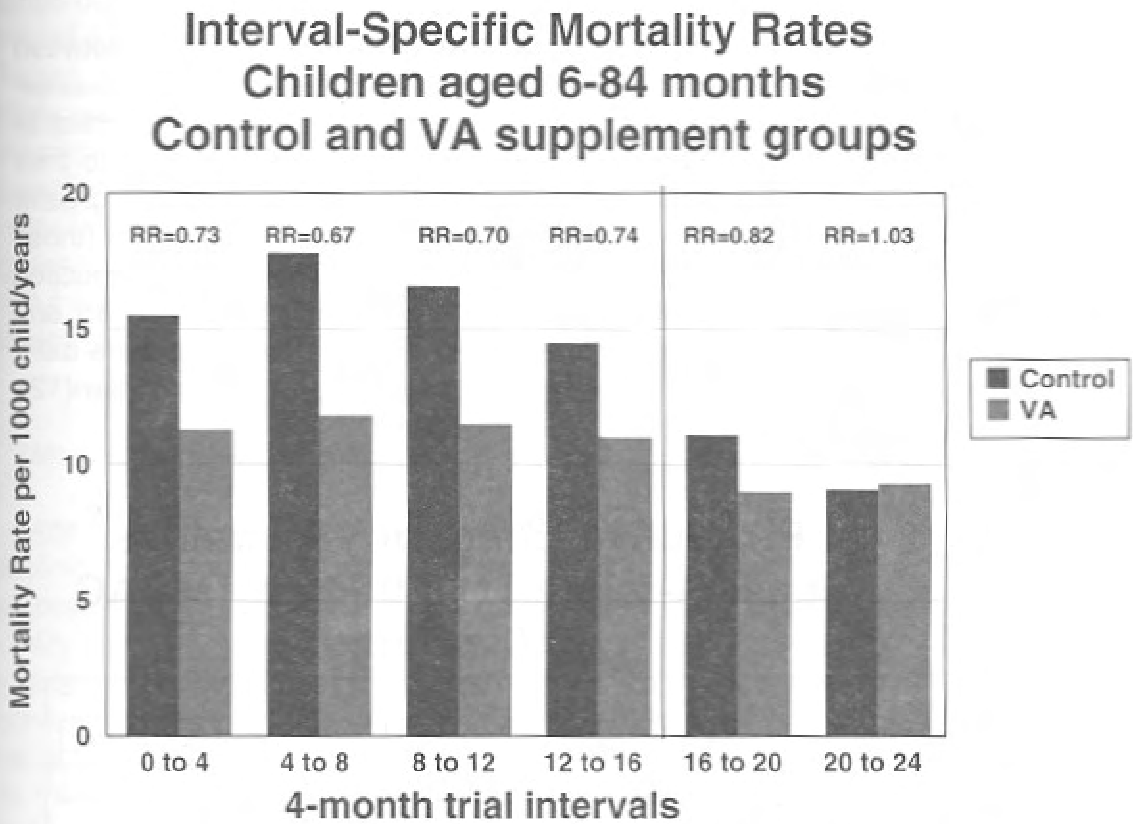
Table 8.1: Impact of Vitamin A Supplementation[1] on child mortality by sex and age

	Control			Vitamin A			
	Child-years[2]	Deaths	MR[3]	Child-years	Deaths	MR	% Decrease in mortality
Sex							
Male	6531	89	13.6	6821	72	10.6	23%
Female	6263	121	19.3	6354	80	12.6	35%
Age at Dosing (months)							
6-11	1315	47	35.8	1393	39	28.0	22%
12-23	2725	75	27.5	2790	53	19.0	31%
24-35	2592	31	12.0	2724	27	9.9	17%
36-47	2633	28	10.6	2657	18	6.8	36%
48-59	2573	25	9.7	2649	13	4.9	49%
60-72	956	4	4.2	964	2	2.1	50%
Total	**12795**	**210**	**16.4**	**13175**	**152**	**11.5**	**30%**

1. 200,000 IU Vitamin A at 12-71 months; half this dose at 6-11 months.
2. Sum of all 4-months intervals (for each sex, age or total) divided by 3.
3. Mortality rate per 1000 child-years.
4. [Control MR - Vitamin A MR/control MR] *100

* from KP West, et al., *The Lancet*, 1991 (1)

Figure 8.1



Solid vertical line indicates time after which all children received vitamin A prophylaxis.
RR = Relative risk of dying in children receiving vitamin A compared to controls.

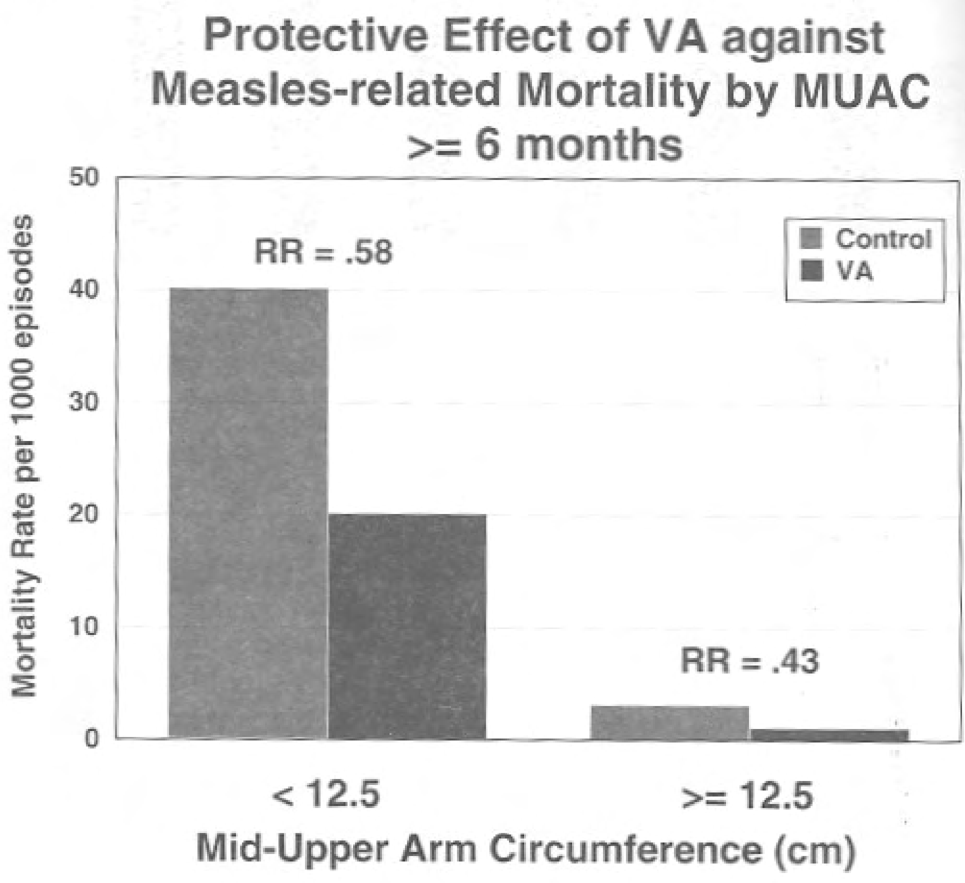
Reductions in Mortality Associated with Severe Morbidity

Vitamin A had the greatest impact on survival of children who were most ill when dosed. Thus, approximately 50% reductions in mortality were observed in children very sick with diarrhea, dysentery or fever who received vitamin A, compared to equally sick children in the control group. (See **Figures 6.3.a-f** in Chapter 6). The morbidity assessment was made at the visit prior to the child's death, when the parents reported the number of days in the past week the child was sick with diarrhea, dysentery, fever, cough, cough with rapid breathing, or ear discharge (see Chapter 6). Less impact on mortality was observed among children who reported 7 days of cough at the visit initiating a 4-month interval. Among these children, a 30% reduction of death in the vitamin A group was seen. There was no effect in children with prolonged respiratory illness.

An overall 76% reduction in measles-related case fatality was observed in children who received vitamin A compared to control children, based on cause of death assigned from review of verbal autopsy interviews.

Figure 8.2 provides another perspective on the relationship between vitamin A and measles. It depicts the effect of vitamin A on residual measles-related mortality, that is, the impact of vitamin A on the mortality of children who were reported to have had measles in the 4-month period prior to their last dosing (and MUAC measurement) visit. There was a relatively greater reduction in measles-associated mortality in better nourished children (those with MUACs of 12.5 or more cm). However, the attributable risk reduction was greater among the acutely malnourished children (those with an arm circumference below 12.5 cm at the previous visit) because there were more deaths among them than among the well-nourished children(12).

Figure 8.2



Implications for Nepal

Reductions in child mortality after supplementation with vitamin A were obtained during another field trial in Jumla reported in 1992, where child mortality was 7-10 times higher than in the terai (4). This trial observed a 29% reduction in mortality among children 6 months of age and older after children received a single, large oral dose of vitamin A, essentially identical to the impact seen in the terai.

The results of the two field trials in Sarlahi and Jumla, combined with findings of beneficial impact from trials in other areas of the world (14), have provided His Majesty's Government with the necessary data and confidence to launch a National Vitamin A Deficiency Prevention Program[1] consisting of periodic vitamin A supplementation combined with approaches to improve availability and consumption of vitamin A-rich foods (yellow-orange fruits and vegetables, green leaves, eggs, dairy products and other appropriate animal sources of vitamin A) by children in the country. Findings from both trials suggest that at least 25,000 deaths of children 6-72 months of age can be averted each year (more than 125,000 over a 5-year period), given prevailing mortality rates, with a continued vitamin A program.

Mortality Under 6 Months of Age

After the first year of NNIPS-1, there appeared to be a small (10%) reduction in mortality with vitamin A receipt among infants under 6 months of age; however, the numbers were too small to draw a firm conclusion on mortality impact. Given the potential for vitamin A to reduce early infant mortality, it was decided to continue the NNIPS-1 trial in young infants for a second year. The results failed to confirm a beneficial impact of providing either a 50,000 IU dose of vitamin A to neonates (under 1 month) or 100,000 IU to infants 1 to 5 months of age. By the end of the trial there was an 11% increase in the risk of mortality in the vitamin A group. The finding was not statistically significant but suggested that a survival benefit could not be expected by dosing infants under 5 months of age with a single, large dose of vitamin A (15). Similar results were reported from Jumla (4). Young infants receiving a 100,000 IU oral dose of vitamin A had a 0.5% excess risk of a bulging anterior fontanel and a 1.6% increased risk of vomiting during the first 24 hours following receipt of vitamin A compared to infants who did not receive vitamin A (16). These side effects are benign (17-18) and shortly disappear on their own. However, the findings suggest that a 100,000 IU dose is unnecessary for infants under 5-6 months of age. Current recommendations to provide young infants with up to 50,000 IU of vitamin A should be followed for prevention programs (19). Alternatively, 25,000 IU at each immunization visit in the first 6 months of life is another safe approach to improving vitamin A status of young infants.

From 5-6 months of age through the sixth year of life vitamin A supplementation (100,000 IU for 6-11 months, 200,000 IU for children 12 months of age and older) can markedly reduce a child's risk of dying from severe infection.

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[1] As of October, 1998, semiannual vitamin A distribution had reached children in 47 of 75 districts in Nepal. Additionally, children in all other districts were receiving vitamin A capsules on the occasion of National Immunization Days (NIDS).

9

EYE DISEASES IN CHILDREN

Children suffer from potentially blinding eye diseases that frequently result from infection, the use of improper traditional medicines in the eye, and malnutrition. Xerophthalmia due to vitamin A deficiency or trachoma (an infection of the inner surface of the upper eyelid that can eventually lead to blindness due to trichiasis in adults), is common in the terai and was investigated during NNIPS-1.

Xerophthalmia

A xerophthalmia survey in a subsample of approximately 3500 preschool children was carried out at baseline, September-December, 1989. A second ocular survey was conducted from February-May 1991 on approximately 6000 children under seven years of age, which included an examination for xerophthalmia and an examination of the inner surface of the upper eyelids for evidence of follicular, inflammatory or scarring trachoma (see section on Trachoma, later in this chapter).

During the baseline survey 120 cases of xerophthalmia were diagnosed by either an ophthalmologist or senior ophthalmic assistant. Cases included 50 children with night blindness (1.4%), 43 cases with Bitot's spots (foamy or bubbly patches on the conjunctival surface), 25 cases with both night blindness and Bitot's spots (0.7%) and 2 cases of corneal xerosis (drying of the corneal surface, 0.1%), providing an overall prevalence of 3.4% in children 1-4 years of age (**Table 9.1**). Sixty-six (55%) of children with xerophthalmia were male and 54 (45%) were female.

Table 9.1: Prevalence of Xerophthalmia at Baseline by Severity and Age
n=3497

		No. (%)				
Age (yr)	**Total No.**	**Night Blind**	**Bitot's Spots**	**Night Blind & Bitot's Spots**	**Corneal Xerosis**	**All Stages**
<1	821	0	0	0	0	**0**
1	858	1 (0.1)	5 (0.6)	0	0	**6** (0.9)
2	869	17 (2.0)	6 (0.7)	6 (0.7)	0	**29** (3.3)
3	860	11 (1.3)	16 (1.9)	10 (1.2)	1 (0.1)	**38** (4.4)
4	910	21 (2.3)	16 (1.8)	9 (1.0)	1 (0.1)	**47** (5.2)
1-4	**3497**	**50** (1.4)	**43** (1.2)	**25** (0.7)	**2** (0.1)	**120** (3.4)

From Khatry, et. al., *Arch Ophthalmol*, 1995, (1)

Table 9.2: Risk Factors for Xerophthalmia in Children Aged 12-60 Months*

Level†	Odds Ratio (95% CI)
Child	
Breast feeding, any (none)‡	0.33 (0.18-0.60)
1-10 times per day (none)	0.39 (0.21-0.71)
>10 times per day (none)	0.13 (0.03-0.59)
Morbidity 1-7 d (none)	
Dysentery, any (none)	2.58 (1.35-4.95)
1-6 d (none)	2.10 (0.99-4.43)
≥ 7 d (none)	6.86 (1.83-25.75)
Fever, any (none)	1.68 (1.08-2.63)
Nutritional status §	
MUAC	0.76 (0.64-0.90)
WHZ	0.74 (0.59-0.94)
WAZ	0.75 (0.61-0.92)
Maternal	
Literate (not)‖	0.10 (0.01-0.76)
Education (none)‖	0.33 (0.10-1.05)
Child deaths (none)‖	1.85 (1.22-2.78)
Household¶	
Head of household	
Literate (not)	0.43 (0.27-0.68)
Education (none)	0.45 (0.27-0.74)
Laborer (other)	2.56 (1.72-3.83)
House quality	
Thatch (other)	3.25 (2.00-5.29)
Single level (two-level)	5.92 (2.97-11.81)
Ownership	
1-3 cattle (≥3)	2.12 (1.35-3.32)
No goats (≥1)	1.59 (1.06-2.36)
No radio (≥1)	2.52 (1.34-4.75)
No watch (≥1)	1.75 (1.02-3.01)
Little land (≥10 kattha#)	1.99 (1.33-2.99)
Child death past year (none)	2.85 (1.43-5.67)

* *OR indicates odds ratio; CI, confidence interval; MUAC mid-upper arm circumference; WHZ weight-for-height z score; and WAZ, weight-for-age z score.*

† *Each OR estimated represents a separate age-and sex-adjusted analysis, except for dose-response breast feeding and dysentery estimates that were derived from models employing dummy variables.*

‡ *Reference category is in parentheses.*

§ *The OR estimates are based on the following per unit increases: 1 cm for MUAC; 1 z for WHZ and WAZ.*

‖ *The OR estimate is adjusted for maternal age.*

¶ *Each household level OR estimate is adjusted for age of head of household.*

\# *One kattha = 0.034 hectare or 0.084 acre.*

---------From Khatry, et. al., *Arch Ophthalmol*, 1995, (1) *Risk Factors*

Epidemiologic studies attempt to identify factors that either cause or directly prevent disease. They also uncover factors indirectly associated with disease which can be used to target individual households and communities for intervention. In NNIPS-1, a study was carried out to compare the presence and intensity of risk factors for xerophthalmia in the 120 cases and selected controls. Findings of this case-control study of child, maternal and household risk factors are summarized in **Table 9.2** (1). The odds ratio (OR) provides an estimate of the odds of a child having xerophthalmia when the risk factor is present relative to the odds of having the disease when the risk factor is absent. The 95% confidence interval (95% CI) provides a range within which the true odds ratio probably lies, with 95% confidence.

Child Factors

Breast feeding is likely to protect children against xerophthalmia. Children who breast fed 1-10 times per day were 61% less likely (OR=.39) to have xerophthalmia than children who did not breast feed. Those breast feeding $\geq$ 10 times per day were 87% less likely (OR=.13) to have xerophthalmia. This may reflect an increased intake of vitamin A through breast milk, improved resistance to infection in breast feeding children (causing less stress on vitamin A stores in the body), a reduction in demand for vitamin A in breast fed children beyond infancy who tend to grow more slowly, or a combination of all three influences.

Xerophthalmic cases were more likely than controls to have dysentery and fever in the past week. Cases were twice as likely to have 1 to 6 days of dysentery (OR=2.10) and nearly 7 times more likely to have 7 or more days of dysentery (OR=6.86) than children without xerophthalmia, indicating that the risk of having or developing xerophthalmia increases with longer or more severe episodes of dysentery.

Xerophthalmic cases were more wasted and stunted than controls. For the most malnourished children, an increase of mid-upper arm circumference (MUAC) of 1 centimeter was associated with a 25% reduction in the risk of xerophthalmia. An increase in a child□s weight-for-height (a one Z-score increase, in WHZ) or weight-for-age (WAZ) was also associated with a 25% reduction in risk of xerophthalmia (i.e., reflected by odds ratios of approximately 0.75).

Maternal Factors

Maternal literacy (ability to read and write a letter) was strongly associated with the risk of a child developing xerophthalmia. Children of illiterate mothers were 90% more likely to develop xerophthalmia than children of literate mothers, suggesting that poorly-educated mothers have inadequate knowledge of nutritional needs of children. Mothers of xerophthalmic children were nearly twice as likely to have had a child ever die previously (OR 1.85) than mothers of non-xerophthalmic children. Risk of child mortality in the past year was nearly 3-fold higher (OR=2.85). This higher risk of mortality, coupled with a higher risk of developing xerophthalmia (2) among siblings of cases, may reflect a clustering of vitamin A deficiency (e.g. due to sharing a poor diet) in a high-risk households over time. The greater risk of sibling mortality in the previous year suggests that these households *currently* are at high-risk. Thus, siblings of cases are also vitamin A-deficient, at an increased risk of developing xerophthalmia and mortality (likely due to infection), and are in need of vitamin A treatment and counseling.

Household Factors

Household wealth (ownership of land and animals, house quality) and social standing (parental education, type of jobs) are inversely related to the risk of xerophthalmia. Children of a literate or educated head of household were less than half as likely to have or develop xerophthalmia than those of illiterate heads of household (OR=~0.44). In contrast, children of laboring heads of household were 2 ½ times more likely to have xerophthalmia than children of heads with other occupations. Household wealth, reflected by good quality houses and ownership of cattle, goats, radios, watches, and land was protective against xerophthalmia. Lack of ownership of any of these latter items was associated with approximately 2-fold higher risk of xerophthalmia in children. Such ownership is likely to reflect a greater ability to provide a nutritious diet (that includes more vitamin A food sources) and hygienic surroundings (reducing risk of infection) for children, thus reducing risk of vitamin A deficiency.

Caste is a traditional class structure that, while officially not recognized, still carries enormous risk for the health, nutrition and survival of children of lower standing. Caste could not be reliably defined in our study; however, field staff were still asked to record the caste of a household based on surnames. By this means, the odds ratios for risk of xerophthalmia in the following castes were observed compared to the risk among Brahmins: Chhetri 2.7, Vaishya 11.8, Shudra 33.3, non-Hindu 30.4. Thus, low caste Shudras and non-Hindus were approximately 30 times more likely to develop xerophthalmia than Brahmins.

Efficacy of Vitamin A in Preventing Xerophthalmia

One effective means to prevent xerophthalmia is to provide preschool children, 12-72 months of age, with a large dose of vitamin A every 4-6 months. The efficacy of 4-monthly vitamin A delivery (200,000 IU) to children in reducing xerophthalmia was evaluated by two ocular surveys of the NNIPS-1 subsample of approximately 3500 children (all children with xerophthalmia at baseline were treated with at least 400,000 IU of vitamin A and referred to health posts for further care, as indicated). After 16 months of supplementation, vitamin A reduced the prevalence of xerophthalmia to a level that was 31% of the prevalence in the placebo-control group, reflecting an overall 69% reduction (**Table 9.3.a**). Another way to examine this impact is to evaluate the effect of supplementation on the apparent incidence of new cases at follow-up among children who were free of xerophthalmia at baseline. Periodic supplementation with vitamin A reduced the incidence of xerophthalmia by 65% (relative risk of 0.35) (**Table 9.3.b**). Thus, high-potency vitamin A supplementation not only reduces mortality risk by approximately 30% but is also 60-65% effective in preventing xerophthalmia in the terai of Nepal.

Table 9.3a: Prevalence of xerophthalmia after dosing

Clinical Signs	Placebo (n=1711) n	%	Vitamin A (n=1871) n	%	Relative Risk
Night blindness	7	0.41	2	0.11	0.27
Bitot's Spots	24	1.40	9	0.48	0.34
Bitot's Spots & Night blindness	4	0.23	1	0.05	0.22
Total	35	2.05	12	0.64	0.31
95% Confidence Interval					(0.12-0.78)

from Katz J, et. al., *Invest Ophthalmol Vis Sci*, 1995 (3)

Table 9.3b: Apparent Incidence of Xerophthalmia after Dosing*

Clinical Signs	Placebo (n=1711) n	No. per 1000/year	Vitamin A (n=1871) n	No. per 1000/year	Relative risk
Night blindness	6	2.6	2	0.8	0.31
Bitot's Spots	12	5.3	5	2.0	0.38
Bitot's Spots & Night blindness	3	1.3	1	0.4	0.31
Total	21	9.2	8	3.2	0.35
95% Confidence Interval					(0.11-0.94)

* from Katz J, et. al., *Invest Ophthalmol Vis Sci*, 1995 (3)

Trachoma

Trachoma is a major cause of blindness worldwide which has left an estimated 6 million people blind and 500 million people infected. Trachoma is the second most common ocular disease in Nepal, according to the National Blindness Survey conducted in Nepal in 1981 (4). In NNIPS-1, a survey was conducted from December 1990 to March 1991 to study the prevalence of trachoma and to identify the risk factors associated with the disease in preschool children (5).

A 20% subsample of children from 40 wards who were 24 to 76 months of age were selected for examination for the presence of trachoma. A total of 891 children were eligible and of these 836 (93.8%) were examined (**Table 9.4**). The prevalence of active trachoma was 23.6%. The prevalence of follicular and intense inflammatory trachoma was 21.9% and 1.7% respectively. Cicatricial trachoma (scarred eyelids) was not seen. Three year old children had the highest prevalence of follicular (25.5%) and intense inflammatory trachoma (4.3%). Males and females had similar prevalence rates.

Table 9.4: Prevalence of Trachoma in Preschool Children in Sarlahi
n=836

Age in years	Follicular (%)	Inflammatory (%)	All Active Trachoma
2	24.6	0.5	25.1
3	25.5	4.3	29.8
4	23.4	1.0	24.5
5	16.5	2.2	18.6
6	21.2	0.0	21.2
Total	21.9	1.7	23.6

from Katz J, et. al., *Br J Ophthalmol*, 1996 (5)

Risk Factors

The prevalence of trachoma varied widely between wards, highlighting community level risk factors (**Table 9.5**). For example, trachoma prevalence was lower in wards where more water per household was available: 21% in wards with less than 10 houses per water source, compared to 28% among those where one water source served 30 or more houses. The presence of a tube well was protective against trachoma; the prevalence of trachoma was 34% in wards without tube wells, versus 20% in others. Multivariate analysis indicated a significant 47% reduction in risk of trachoma for children living in wards with at least one tube well, compared to those in wards without one.

Table 9.5: Risk Factors for Active Trachoma in Sarlahi

Risk factor	Prevalence of trachoma (%)	Adjusted odds ratio*	95% CI
Servants:			
None	24.9		
Any	13.3	.69	0.33,1.44
People/room			
<5	20.5		
≥5	28.1	1.46	1.03, 1.75
Irrigated land (katthas)**			
<20	26.3		
20-99	22.6	1.01	0.68,1.50
≥100	5.6	.39	0.11,1.40
Bicycles owned:			
None	25.1		
Any	17.2	.85	0.51,1.42
Type of House:			
Thatch	25.3		
Cement	5.4	.27	0.06,1.17
Houses/water source			
<10	20.8		
10-20	25.3	1.07	0.68, 1.67
>30	27.8	0.90	0.46,1.78
Tube wells in ward:			
None	34.0		
Any	20.5	.53	0.30,0.93

* Adjusted for age of the child in years (separate odds ratios for each year) and all other factors listed in this table.
** 29 kattas=1 hectare

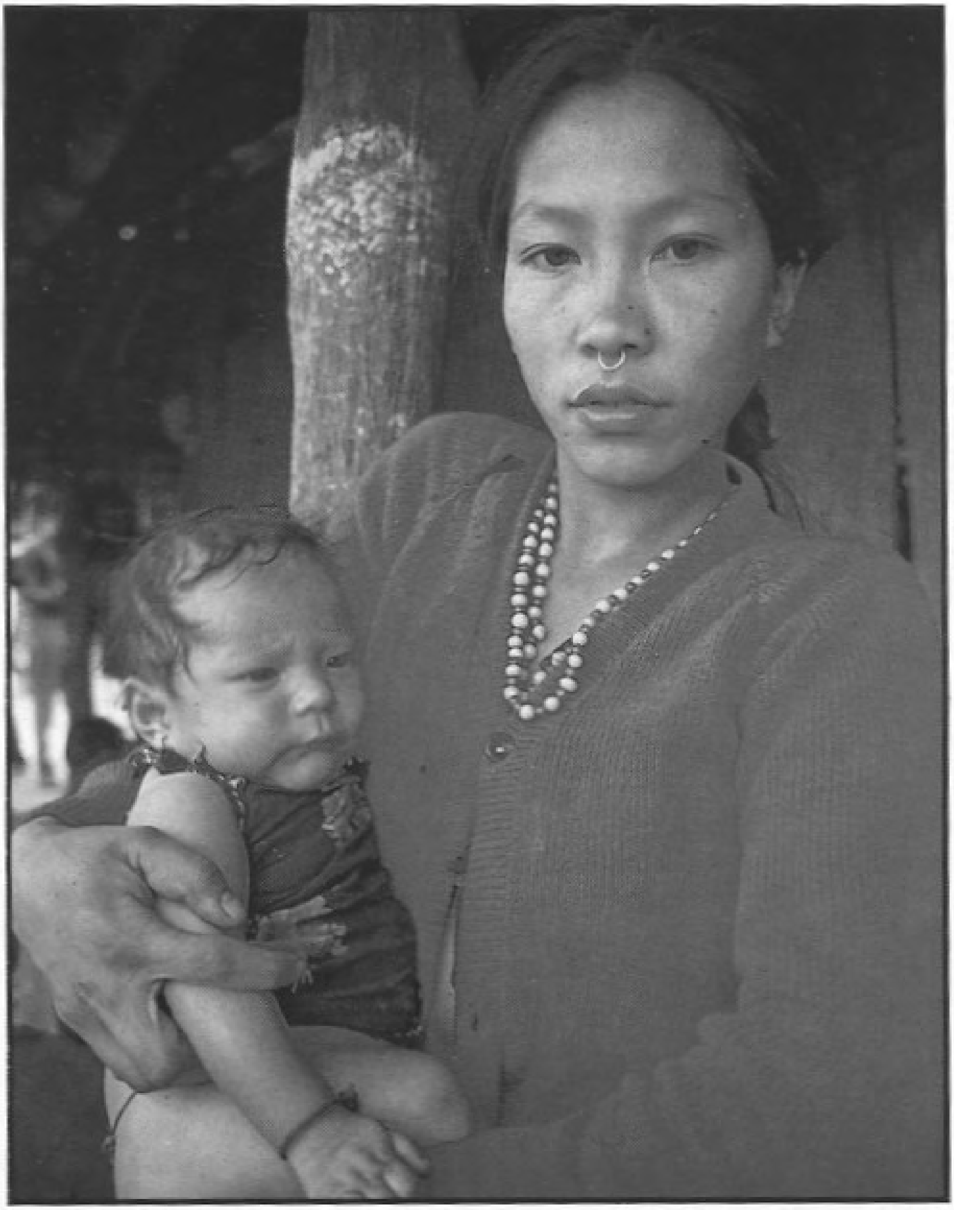
from Katz J, et. al., *Br J Ophthalmol*, 1995 (5)

Crowding within a household was another risk factor. Households that had more than 5 people per room were nearly 1.5 times more likely to have trachoma than those with fewer people per room. General household wealth as measured by the ownership of 100 katthas or more of irrigated land, bicycles, cement houses, and employment of servants was associated with reduced risk of trachoma (adjusted odds ratios=0.39, 0.85 and 0.27, 0.69 respectively). Head of household literacy did not correlate with a reduction in risk of trachoma, in spite of being associated with ownership of household goods and employment of servants. However, children of literate mothers had a lower risk of trachoma (18% versus 24%), although not statistically significantly so (data not shown).

In summary, although follicular trachoma is prevalent, intense inflammatory trachoma is relatively rare and scarring was not observed in this population. Hence, this population of children may not be at high risk of developing trachomatous blindness in adulthood.

10

WOMEN'S HEALTH



NNIPS-1 examined the quality of life of women in Sarlahi through its surveys of the mothers of the preschool-aged children enrolled in the trial. Mothers were evaluated with respect to their age, literacy, parity, previous child mortality experience, nutritional status and lifestyle habits such as frequency of smoking and alcohol consumption. The findings reflect a young and illiterate population of women with strikingly high risk of malnutrition, morbidity and child mortality. **Table 10.1** summarizes several of these factors.

Table 10.1 Maternal Age, Literacy, Parity and Previous Child Mortality
n=21,610

Age	No.	(%)	Literate %	Parity Median	Parity IQR*	Previous Child Mortality Median	Previous Child Mortality IQR*
≤ 19	2241	(10)	17	1	1-1	0	0-0
20-24	6340	(30)	16	2	1-2	0	0-0
25-29	5771	(27)	9	3	2-4	0	0-1
30-34	3425	(16)	6	5	4-6	1	0-2
35-39	2447	(12)	4	6	5-7	1	0-2
≥40	1386	(6)	2	7	6-9	2	1-3
All	21610	(100)	10	3	2-5	0	0-1

* Inter Quartile Range

Literacy and Parity

Illiteracy is a significant problem in this population of women, among whom only 10% can read and write. Younger women, however, are 8 times more literate than the older women; approximately 17% of women under 25 years are literate, compared to 2% of women 40 years and older, reflecting an increasing trend in the past decades toward education of girls. The observed literacy rate of young women (17%) may underestimate the actual rate in the population, as these are married mothers who are less likely to pursue an education.

Ten percent of mothers of preschool children in Sarlahi are in their teens. The majority are in their twenties (57%) and thirties (28%), with a few over 40 years of age (6%). The median age in this cohort is 26 years, by which time women have had, on average, 3 children. By the time women have reached 30-34 years of age, they have had five children, while women who are forty years or older have had seven live born children, two of whom have died. The national average fertility rate is currently stated to be approximately 4.8 for rural Nepal (1). It appears that the size of families may be declining in Nepal, perhaps as a result of increased emphasis on family planning and decreasing child mortality. If so, it is likely that the parity of the young women assessed in this study will not reach that of their older counterparts.

Previous Child Mortality

The experience of child loss begins early for women in Sarlahi and continues throughout their child bearing years. **Table 10.2** shows the percent of mothers with deceased children rising by age. Seven percent of teenaged mothers in this population have lost a child. Twenty-three percent of women in their twenties have lost at least 1 child. Among women in their early thirties, 60% have lost one child and 30% have lost two or more children. Over 75% of mothers 40 years or over (who still have a preschool child) have had at least one child die.

Table 10.2: Percent of Mothers, by Age Group, with Previous Child Deaths
n=21,610

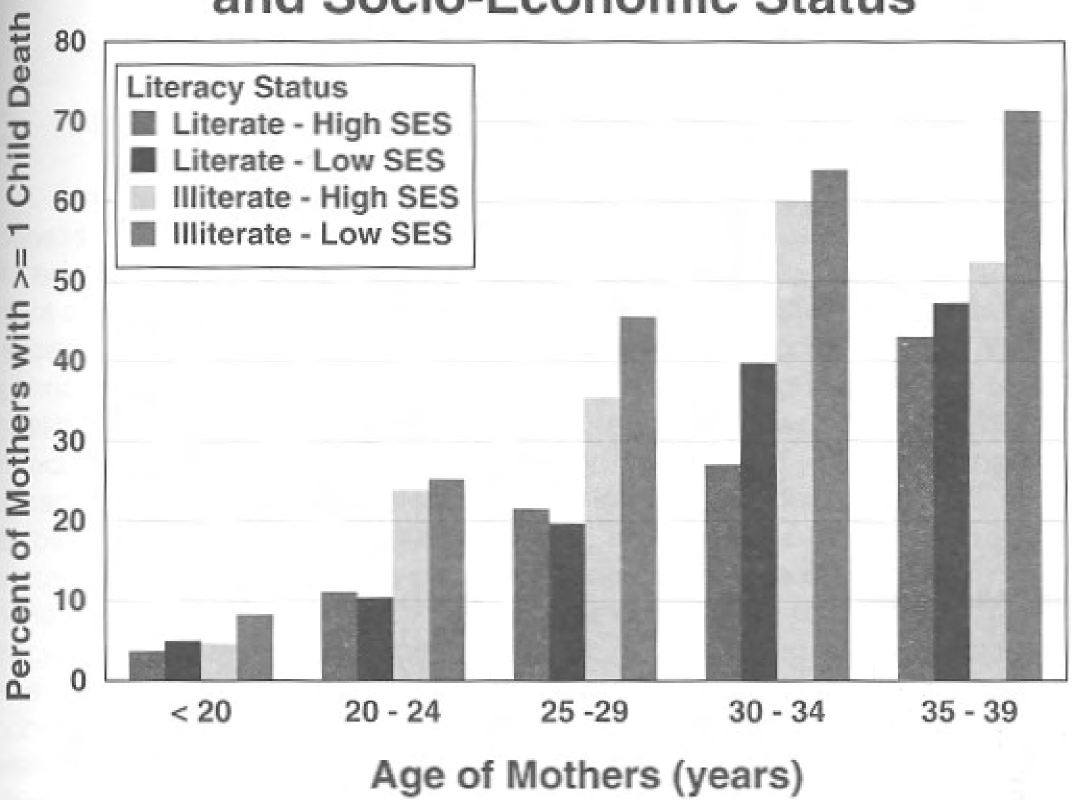
Age of Mother (yrs)	Number of Deceased Children 0	1	2	3	4	5	6	Any
	(% of Mothers)							
<20	93	7	0	0	0	0	0	7
20-24	78	18	4	1	0	0	0	22
25-29	59	27	10	3	1	0	0	41
30-34	40	31	17	8	4	1	0	60
35-39	31	28	20	12	6	2	0	69
≥40	23	23	21	15	9	5	1	76

Maternal Literacy and Child Mortality

In this population a strong, statistically significant association was found between maternal illiteracy and risk of child mortality, which is not accounted for by socio-economic status. Whether of low or high socio-economic status, literate women experience less child mortality than do illiterate women. **Figure 10.1** compares the percent of literate and illiterate women in different age brackets who have lost one or more children, for low and high socio-economic groups. 14,781 women <40 years of age were evaluated. Women whose families were landless or who owned less than 1 hectare of land were said to be of low socio-economic status, and those whose families owned >4 hectares of land were said to be of high socio-economic status. (See Chapter 2 for assessment of family socio-economic status). The protective effect of literacy on child mortality is evident in both groups. For poorer women, there is an overall 61% reduction in the risk of losing one or more children for literate women, compared to non-literate women (OR=.39, 95% CI .34 - .44, p<.001). For women of high socio-economic status, there is a 58% reduction in risk of losing one or more children for literate women compared to non-literate women (OR=.42, 95% CI .31 - .56, p<.001).

Figure 10.1

Previous Child Mortality by Maternal Literacy and Socio-Economic Status



In summary, literate women experience significantly less child mortality than non-literate mothers, across socio-economic strata. The imperative is clear to continue efforts to improve women's literacy in Nepal, which in turn may lead to improved child survival.

Nutritional Status

Nutritional status of women, assessed by mid-upper arm circumference (MUAC), was examined among mothers of preschoolers who were enrolled in the eye and nutrition subsample of NNIPS-1 (n=1936). The mean and overall distribution of mid-upper arm circumference reveals a population of women who are markedly wasted, of whom approximately 75% between the ages of 19 and 45 years lie below the 5th percentile of American women (2), adjusted for age (**Table 10.3**). Middle-upper arm circumference values are lower for illiterate vs literate mothers, and decrease slightly with 2 or more previous child deaths.

Table 10.3: Mid-upper Arm Circumference (MUAC) of Mothers in Sarlahi
n=1936

MUAC	No.	Percent
<18.0	20	1.0
18.0 - 20.9	614	31.7
21.0 - 23.9	1082	55.9
≥ 24.0	220	11.4

Maternal characteristics:	**No.**	**MUAC in cm** Mean (Standard Deviation)
Landholding of family:		
Landless	492	21.3 (1.83)
1-25 katthas	864	21.8 (1.80)
26-100 katthas	520	22.0 (1.83)
>100	60	22.2 (1.59)
Literacy:		
Yes	177	22.5 (2.07)
No	1759	21.6 (1.78)
Parity:		
1	411	21.7 (1.64)
2-3	664	21.8 (1.71)
4-5	440	21.7 (1.94)
≥6	421	21.7 (2.05)
Previous Child Deaths:	1168	21.8 (1.73)
1	415	21.8 (1.73)
≥2	353	21.3 (2.01)

Percent of Sarlahi women below the 5th percentile of American women:

Age	5th percentile NCHS*	% below 5th percentile
19 - 24.9	22.1	58.4
25 - 34.9	23.3	82.5
35 - 44.9	24.1	86.8
≥ 45.0	24.2	27.5

*NCHS: National Center for Health Statistics, College Park, MD

Lifestyle Habits

Questions about smoking and drinking habits were asked of 2499 mothers of preschoolers enrolled in the eye and nutrition subsample of NNIPS-1. Among those surveyed, half (50.6%) reported smoking, nearly all of whom smoked on a daily basis (**Table 10.4**). Two-thirds of women reported never drinking alcohol, and one-quarter reported drinking on an occasional basis. Seven percent reported drinking alcohol on a daily basis.

Table 10.4: Smoking and Drinking Habits of Mothers of Preschool Children
n=2499

Frequency	Smoking N (%)	Drinking N (%)
Never	1236 (49.5)	1698 (67.9)
Occasionally	50 (2.0)	630 (25.2)
Daily	1213 (48.5)	171 (6.8)

Vitamin A Deficiency

A survey was conducted during NNIPS-1 on the prevalence of night blindness among pregnant and lactating mothers of a subsample of preschool children (3). Mothers were asked about night blindness ("rataundhi") during the current or most recent pregnancy or during the first six months of lactation as a way of assessing the extent of vitamin A deficiency in the community (**Table 10.5**). Approximately 4% of pregnant-and-lactating women reported being night blind, suggesting the risk of this condition early in pregnancy. Twelve percent of pregnant, non-lactating women reported having been night blind (reflecting risk in later pregnancy) and 16% of mothers who were interviewed during the first six months after birth reported being night blind during or after their most recent pregnancy, representing the most complete estimate of the percentage of women at-risk of night blindness during or following pregnancy. The risk of night blindness decreased with literacy and greater socioeconomic status (e.g., ownership of goats and watches). These findings have stimulated a much more detailed investigation into night blindness during pregnancy that will be reported in a subsequent monograph. However, the results of this study provide evidence that vitamin A deficiency, based on history of night blindness, is a previously unrecognized public health problem in pregnant and lactating women in the rural terai.

Table 10.5: Number and percentage of mothers currently night blind (XN) by pregnancy and lactation status
n=426

Current Status	Total	Number With XN	Percent
Pregnant & lactating	82	3	3.7
Pregnant, not lactating	103	12	11.7
Lactating (<6 months)	241	15	6.2
Total	426	30	7.0

Appendix I: NNIPS-1 Design and Methods

Goals and Objectives

The Nepal Nutrition Intervention Project - Sarlahi (NNIPS-1) was carried out jointly by the Nepal Netra Jyoti Sangh and The Johns Hopkins University, Baltimore, Maryland, U.S.A., with financial and technical support from USAID, Washington, D.C. and Task Force Sight and Life of Roche, Switzerland, local assistance from the Sushil Kedia Seva Mandir, under the auspices of the Social Welfare Council and with the approval of the Nepal Health Research Council of His Majesty's Government of Nepal. The specific aims of NNIPS-1 were as follows:

Specific Aims

1. To assess the efficacy of large dose Vitamin A supplementation every 4 months in reducing preschool child mortality by at least 25% over a 20 months period.

2. To assess the impact of large dose Vitamin A supplementation every 4 months in reducing the prevalence of diarrhea and respiratory tract infection (by history) among preschool children.

3. To evaluate the degree to which large dose Vitamin A supplementation every 4 months improves preschool child growth.

Project Design and Methods.

NNIPS-1 was a randomized, community-based, double-masked, placebo controlled supplementation trial carried out from September 1989 to December 1991 in the rural plains of Sarlahi district. 29 village development committees (261 wards) were selected to participate in study. All households in the selected VDCs in which children under 60 months of age were living at the time of the baseline census were eligible to participate. Children under 60 months of age either at baseline or who were born into a participating household during the course of the trial were enrolled.

The supplementation in the trial was coded as 10, 20, 30, 40. Two of these supplements contained 200, 000 IU of Vitamin A and 40 IU of Vitamin E and two supplements contained a low dose 1000 IU of Vitamin A and 40 IU of Vitamin E. Throughout the trial both the investigators and participants were masked to the actual supplement identification.

1. Children 12 months of age or older were given the entire contents of the capsule (200,00 IU). Infants 6-11 months of age were given half the contents of the capsule, approximately 6 drops (100,000 IU), and infants under 6 months of age received 1/4 of the total content of the capsule, approximately 3 drops (50,000 IU).

2. Approximately 38,000 children were enrolled in the 2 year study from the 261 wards in 29 VDCs. Participation of wards, household and children in the trial was voluntary at all times. The ward served as the unit of treatment allocation and after a random start each of 261 wards was systematically allocated to one of the four coded supplements.

Field Procedures

Ward Mapping: Wards were initially visited by field teams to identify and uniquely number all houses. All structures and prominent landmarks in a ward were mapped according to standardized procedures.

Baseline Visit: Following ward mapping and team training, a house to house baseline census was conducted to identify households with children less than 60 months of age at the time of visit, enroll and enumerate eligible children, collect pertinent information and give the allocated supplement. A one week morbidity history of diarrhea, dysentery, high fever, cough with or without rapid breathing, ear discharge and history of measles in past 4 months were also obtained.

Follow-up Visits: Approximately 4 months after the baseline census, wards were visited again. The vital status of each previously visited child was ascertained and newborns enrolled and the same history of recent morbidity history taken. All children enumerated in the household were given their allocated supplement. The census and supplementation was repeated every 4 months for 8 visits.

"Eye and Nutrition" subsample: Children received an ocular examination and were assessed for nutritional status in a random 15% subsample of 40 wards. Children were measured for weight, height/length, tricipital and subscapular skin folds and mid-upper arm circumference at each visit. A total of two ocular examinations were conducted in 2 years.

Vital Events Surveillance and Verbal Autopsy Interview.

Children who had died since the team's last visit were identified by means of the regular four-monthly census team and by an independent vital event surveillance every two months in a ward. Following a report of a child death in a participating ward, a specially trained vital investigator visited the household to identify morbid events preceding and leading up to the death of the child. Information collected was independently reviewed by two project physicians and assigned a probable and possible cause of death.

Appendix II: NNIPS-1 Staff

Dr. R. P. Pokhrel	Chairman, NNJS
Dr. S. K. Khatry	Director
Sharada Ram Shrestha	Deputy Director
Dr. R. K. Adhikari	Pediatric Consultant
Hari Govinda Kayastha	Chief Accountant
Binod Bikram Adhikari	Logistics Officer
Bijay Kumar Thapa	Secretary
Pashupati Dhital	Office Assistant
Kumar Khadka	Driver
Prithvi Bahadur Bhandari	Peon
Sundar Bahadur Balampaki	Night Watchman
Udhab Kumar Khadka	Data Supervisor
Sunita Pant	Data Operator
Uma Sharma	Data Operator
Sahita Amatya	Data Operator
Rabi Moktan	Data Operator
Rajen Rai	Data Operator
Shakuntala Singh	Data Operator
Noor Nath Acharya	Field Administrator
Bishnu Bahadur Shrestha	Assistant Field Administrator
Tirtha Raj Shakya	Field Supervisor
Dev Narayan Mandal	Field Supervisor
Rabindra Kumar Shrestha	Forms Editor Supervisor
Ajit Khadka Chhetri	Driver
Kumar Lama	Driver
Raman Prasad Upadhyaya	Clerk
Ram Bahadur Tamang	Runner
Lal Prasad Bhattarai	Peon
Arun Kumar Bhetwal	Team Leader
Gokarna Subedi	Team Leader
Dhan Raj Lama	Team Leader
Dhruba Bahadur Khadka	Team Leader
Uma Shankar Shah	Team Leader
Nabo Narayan Jha	Vital Investigator
Dacha Raj Wagle	Vital Investigator
Shiv Raj Bhattarai	Vital Investigator
Padam Bahadur Lama	Vital Investigator

Chandeswor Nepali	Ward Reporter
Ram Ekbal Raut	Ward Reporter
Ram Prayag Sahani	Ward Reporter
Nageswor Ram	Ward Reporter
Ram Hari Ghimire	Ward Reporter
Govinda Prasad Mainali	Registrar
Kalawati Giri	Anthropometrist
Rajeswori Kafle	Anthropometrist
Baidhya Nath Yadav	Anthropometrist
Jokhu Bahadur Darlami	Anthropometrist
Ambika Aryal	Forms Editor
Tej Narayan Chaudhary	Forms Editor
Niraj Kumar Singh	Forms Editor
Laxman Bahadur Rayamajhi	Forms Editor
Arun Bhattarai	Forms Editor
Menuka Chalise	Forms Editor
Shyam Lal Dhami	Interviewer
Biyasi Kumar Danuwar	Interviewer
Chudamani Dhami	Interviewer
Lok Bahadur Basnet	Interviewer
Matrika Prasad Dhungel	Interviewer
Jaisi Lal Ran Yadav	Interviewer
Roshan Kumar Shrestha	Interviewer
Purna Prasad Kharel	Interviewer
Uttam Raj Poudel	Interviewer
Ram Narayan Chaudhary	Interviewer
Bidhya Nanda Yadav	Interviewer
Dilli Ram Khanal	Interviewer
Bikram Tamang	Interviewer
Mohan Yadav	Interviewer
Dipak Prasad Ghimire	Interviewer
Bhoj Bahadur Karki	Interviewer
Bikram Prasad Chaudhary	Interviewer
Prakash Kumar Shrestha	Interviewer
Nagendra Prasad Chaudhary	Interviewer
Anil Kumar Karna	Interviewer
Punya Prasad Dahal	Interviewer
Ramananda Kapar	Interviewer

Dr. B. D. Chataut	Joint Secretary, Ministry of Health and Executive Director of NNIPS, Jan.-July, 1989
Dr. David Calder	Chief, Office of Health, USAID/Nepal (1989-90)
Dr. John Gmunder	Task Force Sight and Life, Hoffman LaRoche, Switzerland
David Piet	Chief, Office of Health, USAID/Nepal (1990-92)
Yogesh Vaidya	Chief, Nutrition Section, Central Food Laboratory
L. N. Sharma	Senior Ophthalmic Assistant
Makar Dhoj Thapa	Senior Ophthalmic Assistant
Sanu Raja Ranjit	NNJS Administrator
Tika Paudel	Ophthalmic Assistant
Chin Maya Nepali	Office Helper

Johns Hopkins University Collaborators

Dr. Keith P. West, Jr.	Principal Investigator
Dr. Alfred Sommer	Dean, School of Hygiene and Public Health, JHU
Dr. Joanne Katz	Co-investigator/ Statistician
Dr. James Tielsch	Epidemiologist
Steven C. LeClerq	Field Director and JHU In-country Representative
Elizabeth K. Pradhan	Research Coordinator/ Data Manager
Lai Chu See	Biostatistician
Lilianna Clement	Laboratory Technician
Anita V. Shanker	Anthropologist
Lee Shu-Fune Wu	Biostatistician
Joe Canner	Computer Systems Specialist
Ravi M. Ram	Co-investigator for NNIPS-1 Follow Up

Appendix III: List of Sarlahi VDCs Participating in NNIPS

PATTHARKOT
SASAPUR
ATRAULI
HARIAUN
DHUNGRE KHOLA
KARMAIYA
GHURKAULI
MURTIYA
SHANKARPUR
RAJGHAT
BARHATHAWA
LAUKAT
SUNDARPUR CHUHARWA
MANPUR
HARKATAWA
BHAWANIPUR
DHANKAUL
SALEMPUR
KABILASI
PHARHADAWA
LAXMIPUR KODARKOT
HARIPUR
JABDI
NETRAGANJ
LALBANDI
RANIGANJ
ISHWARPUR
PIDARI
PIPARIYA
JANAKINAGAR

Appendix IV: Growth Tables for Sarlahi Children

Tables A.1 - A.3 present average heights, weights and left middle upper arm circumferences (MUAC) for 4315 male and female children measured during NNIPS-1 in Sarlahi District. This data is presented separately by sex and completed month of age, for each month during infancy and every six months from age 1 - 5 years. Infant heights and weights from ages 0 - 4 months are similar to those of the WHO growth reference, but from 5 months through 12 months the mean Sarlahi infants' heights and weights fall behind the WHO reference. At 12 months and older, the Sarlahi heights and weights stabilize at approximately 2 standard deviations ("z-scores") below the WHO medians (see also Chapter 4).

The data below can be used for comparisons with growth data from populations elsewhere in Nepal and South Asia. Such comparisons can assist in determining how other populations of children rank nutritionally with respect to the Sarlahi sample of children in the east-central terai. Differences in the average heights, weights or MUACs may be indicative of greater or lesser severity of stunting or wasting malnutrition and thereby can inform decisions about programmes and resources appropriate for these populations.

TABLE A.1

Average Heights of Children in Sarlahi District, Nepal (1989), by sex
(Age in months for infancy and every 6 months up to 60 months)

AGE	MALE	FEMALE
0	49.6	49.1
1	51.6	51.0
2	55.5	54.8
3	58.5	56.4
4	60.5	58.9
5	61.8	60.3
6	63.5	62.3
7	65.1	63.2
8	66.3	65.1
9	66.6	66.2
10	68.2	66.6
11	69.3	66.5

AGE	MALE	FEMALE
12	69.5	68.0
18	74.2	72.5
24	77.7	76.6
30	81.2	79.0
36	85.6	84.4
42	89.0	87.1
48	93.7	91.2
54	95.2	94.1
60	97.4	98.0

TABLE A.2

Average Weights of Children in Sarlahi District, Nepal (1989), by sex
(Age in months for infancy and every 6 months up to 60 months)

AGE	MALE	FEMALE
0	2.9	2.8
1	3.4	3.1
2	4.5	4.1
3	5.2	4.6
4	5.7	5.2
5	6.1	5.6
6	6.2	5.8
7	6.7	5.9
8	7.0	6.5
9	6.9	6.6
10	7.4	6.7
11	7.5	6.3

AGE	MALE	FEMALE
12	7.1	6.9
18	8.4	7.8
24	9.4	8.9
30	10.4	9.7
36	11.3	10.8
42	12.2	11.5
48	12.8	12.3
54	13.5	13.3
60	13.9	13.6

TABLE A.3

Average MUAC of Children in Sarlahi District, Nepal (1989), by sex
(Age in months for infancy and every 6 months up to 60 months)

AGE	MALE	FEMALE
0	9.6	9.7
1	10.2	10.1
2	11.7	11.2
3	12.5	11.9
4	12.7	12.1
5	13.1	12.4
6	12.8	12.5
7	13.2	12.4
8	13.2	12.8
9	12.8	12.5
10	13.4	12.9
11	13.1	12.1

AGE	MALE	FEMALE
12	12.8	12.6
18	13.2	12.9
24	13.7	13.3
30	13.8	13.6
36	14.0	13.9
42	14.4	14.3
48	14.1	14.1
54	14.2	14.5
60	14.4	14.1

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Appendix VI: **Map of Sarlahi District**